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WIND TUNNEL MEASUREMENTS OF THE MAGNUS INDUCED SURFACE PRESSURES ON A SPINNING ARTILLERY PROJECTILE MODEL IN THE TRANSONIC SPEED REGIME

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by Miles C. Miller
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RESEARCH DIRECTORATE

September 1986

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The aerodynamic surface pressures on a spinning projectile were experimentally obtained during transonic wind tunnel tests employing a novel model design and instrumentation arrangement. A series of remotely controlled pressure taps located in the non-spinning inner portion of the wind tunnel model detected the surface pressures through vent holes in the spinning outer portion. Data were obtained at spin rates of 0 and 82 Hz for angles of attack of 0, 4, and 10 deg. Testing was conducted at a Mach number of 0.94 and Reynolds number of 4 $\times 10^6$ per foot. The results illustrate the large circumferential pressure variation over the boattail region as well as the nonlinear effect of the angle of attack. The integrated pressure data indicate not only the total Magnus force and moment coefficients for the model, but also the individual contributions of the various body components. Keywords:

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PREFACE

The work described in this report was authorized under Project No. 1L162618AH80, Launch and Flight Technology, Exploratory Development. This funding supported the design, fabrication, testing, and analysis aspects of the effort. This work was started in October 1979 and completed in September 1984.

Acknowledgments

This project required the support of several organizations and was made possible because of the efforts of certain key individuals who the authors would like to recognize and thank.

All funding for the design, fabrication, testing and analysis associated with this study was provided by the U.S. Army Ballistics Research Laboratory. The funding and support provided by Dr. Charles H. Murphy, Chief of the Launch and Flight Dynamics Division, were essential to its completion.

The fabrication of the wind tunnel model and sting components was accomplished by the Experimental Fabrication Branch, Research, Development and Engineering Support Directorate, Chemical Research, Development and Engineering Center (formerly the Chemical Systems Laboratory). In particular, the exceptional skills of Coy Barker, David Blake, Kenneth Younger, Scotty Johnson, and Llewellyn Thompson provided the high quality test items required.

A key element in the success of this study was the o-ring utilized in the sliding seal. The cooperative efforts of Ike Royster and Dutch Haddock of the Parker Hannifin Corporation in providing advice and samples facilitated the evaluation and selection of the required o-ring configuration and material.

Access to the NASA Ames, 14-foot transonic wind tunnel was gained through the test justification support provided by Harold R. Vaughn and Albert E. Hodapp of the Aeroballistic Division, Sandia National Laboratories and Carman Spinelli, XM785 Project Manager at the U.S. Army Armament Research and Development Center.

Important guidance for the test procedure and interpretation of the resulting data was obtained from Dr. William Oberkampf of the Aeroballistic Division, Sandia National Laboratories.

Individuals from the Aerodynamics Research and Concepts Assistance Branch also contributed to this effort. Owen C. Smith, Jr., in addition to his previous efforts in developing the sliding seal design, participated in several of the functional check-outs of the model and instrumentation systems prior to the wind tunnel test. Daniel J. Weber developed the computer program necessary to analyze the relatively large volume of complex data reduction associated with force and moment coefficient pressure integration.

Finally, the authors express their appreciation to Abraham Flatau for his encouragement and support, which allowed the sliding seal experimental technique to be sequentially evolved from the initial concept in 1975 to the current application.

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WIND TUNNEL MEASUREMENTS OF THE MAGNUS INDUCED SURFACE PRESSURES ON A SPINNING ARTILLERY PROJECTILE MODEL IN THE TRANSONIC SPEED REGIME

1. INTRODUCTION

A spinning projectile in flight produces aerodynamic surface pressures that have led to the so-called Magnus effect. This external aerodynamic phenomenon due to the combination of projectile spin and angle of attack produces forces and associated moments that have resulted in flight instabilities for several military projectiles.[1-3] Although the Magnus force is only a 10th to a 100th of the normal force, it can have a large detrimental influence on range and accuracy. Figure 1 contains flight test data illustrating the yaw growth experienced by an artillery projectile experiencing a Magnus instability. A concerted effort has been underway to experimentally investigate the fundamental Magnus phenomena and to develop theoretical models and analytical techniques to describe the effect.[4,5]

This report presents wind-tunnel test measurements of the aerodynamic surface pressures on a full scale spinning model of the M549/XM785 artillery projectile in the transonic speed regime. The model, a secant ogive, cylinder, boattail configuration with an 8-inch diameter and a 5.5 caliber length, was evaluated both with and without a rotating band. The model was tested in the NASA-Ames 14 Foot Transonic Wind Tunnel. Circumferential pressure distributions were obtained at several longitudinal locations on the model, with emphasis on the cylindrical and boattail sections. The model was tested at angles of attack of 0, 4, and 10 degrees and spin rates of 0 and 4,900 rpm. All testing was done at a Mach number of 0.94, which corresponds to the critical Mach number for this projectile configuration.

The model configuration, scale, and test conditions were selected to complement a series of wind-tunnel tests conducted by the Ballistics Research Laboratory (BRL) that involved an extensive wind-tunnel investigation of a similar projectile configuration and scale at the NASA-Langley 8-Foot Transonic Wind Tunnel.[6,7] During these tests, the aerodynamic forces and moments as well as velocity profiles of the boundary layer were obtained on both a spinning and non-spinning model. The aerodynamic surface pressures were also measured, but only for the non-spinning condition.

The tests were conducted to extend the data base for this projectile configuration and represent the first time that the aerodynamic surface pressures have been experimentally determined on any spinning projectile. Several other test objectives were also achieved as shown in Figure 2. The results allow a detailed insight into the Magnus phenomena as well as providing experimental data to support the evolution and validation of theoretical and numerical analyses. In addition, the test demonstrated the use of a new experimental method to obtain surface pressure data.

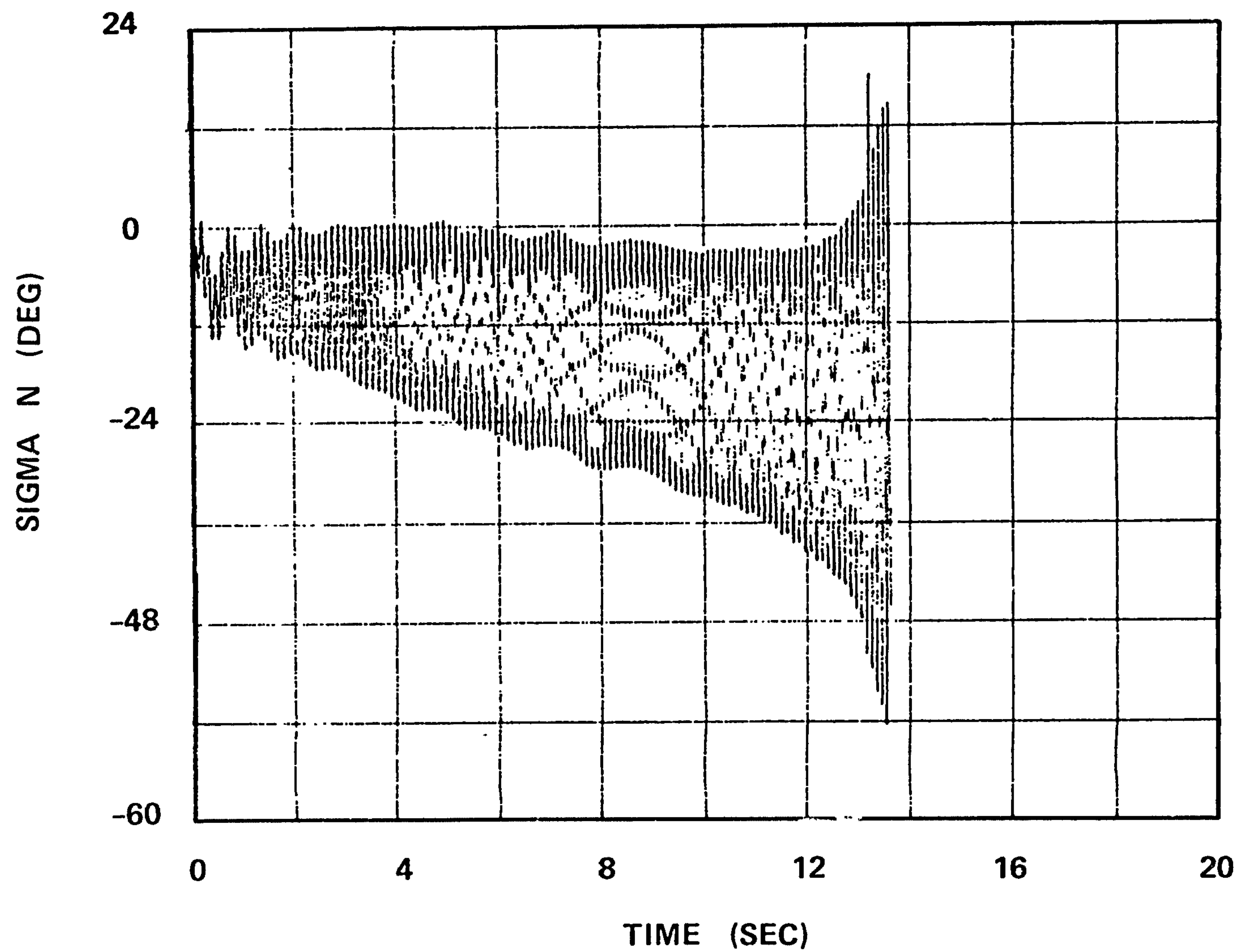


Figure 1. Time History of Projectile Yawing Motion Resulting from Magnus Instability

- DETERMINE MAGNUS CHARACTERISTICS OF PROJECTILE AT CRITICAL (TRANSONIC) MACH NUMBER
  - EFFECT OF SPIN
  - EFFECT OF ANGLE OF ATTACK
    - ATTACHED FLOW ($\alpha = 4^{o}$)
    - SEPARATED FLOW ($\alpha = 10^{o}$)
  - EFFECT OF ROTATING BAND
- COMPLEMENT PREVIOUS TEST DATA
  - FORCE AND MOMENT
  - NON-SPINNING SURFACE PRESSURE
  - BOUNDARY LAYER
- INTERPRET GENERAL MAGNUS PHENOMENA
- DEMONSTRATE NEW TESTING TECHNIQUE
- PROVIDE DATA TO SUPPORT AND VERIFY THEORETICAL COMPUTATIONS

Figure 2. Objectives of the Wind Tunnel Tests

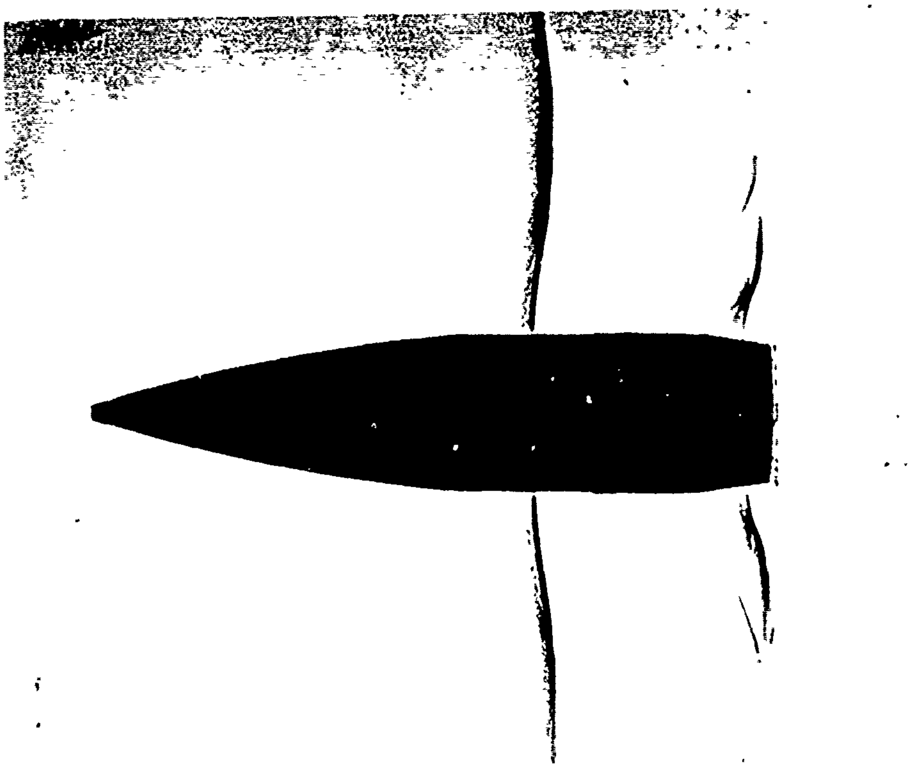
Mach number 0.94 represents the critical Mach number for this projectile (i.e., the condition where the projectile possesses the maximum destabilizing aerodynamic effects). Figure 3 depicts the flow field that exists over the projectile at this transonic condition. The shadowgraph shows that two separate shock waves occur: one just downstream of the ogive/cylinder junction and the other just downstream of the cylinder/boattail junction. This combination of subsonic and supersonic flow produce a complex surface pressure distribution as shown.

In addition to the basic angle of attack of 0 degree, the test included angles of attack of 4 and 10 degrees because they produce an attached flow and separated flow, respectively, over the boattail region of the model. The aerodynamic characteristics undergo a significant change between these two angles of attack, and the resulting pressure data would be of great interest. The spin rate of 4,900 rpm represents a tip speed ratio of .17 corresponding to a Mach 0.94 muzzle velocity condition. Finally, the influence of the rotating band on the Magnus surface pressures in the transonic speed region is of particular concern. This situation is currently being addressed by using computational fluid dynamic methods, and little experimental data exists to support or verify these theoretical analyses.[8,9]

2. BACKGROUND

During the past several years, the Aerodynamics Research and Concepts Assistance Branch has systematically evolved a new and unique method to experimentally measure the aerodynamic pressures acting over the external surface of the spinning wind tunnel model. The method is based on an unconventional model design and instrumentation arrangement. The model is composed of two parts. A non-spinning inner portion of the wind tunnel model, containing the instrumentation, detects the surface pressure through a series of vent holes in the spinning outer portion of the model, the pressure being retained for measurement by means of a sliding seal arrangement.[10] This method avoids the problems and limitations of conventional test techniques[11,12] and allows surface pressures to be measured on spinning bodies at any attitude and flow regime. In addition, the body can include indentations or protuberances.

The validity and performance capability of the testing method has been demonstrated in stages, beginning with a simple spinning right-circular cylinder in cross flow that verified the basic concept.[13] A second major series of tests involved the measurement of the surface pressures on a spinning Magnus autorotor,[14] which extended the testing method to bodies having irregular surface features and an unsteady, periodic flow field. Other studies investigated improved instrumentation elements, in particular, the critical sliding seal units. This latter work evolved a magnetic fluid seal[15] (to reduce friction effects), a miniature sized seal, and a remotely selectable pneumatic seal, all intended to increase the versatility and accuracy of the testing method. These efforts were funded by the BRL, CRDEC, and Sandia National Laboratories, respectively. Portions of the material presented in this report have been disseminated through presentations at conferences[16] and articles in technical journals.[17] A concise summary of the evolution of the experimental technique and the results obtained has also been published.[18]



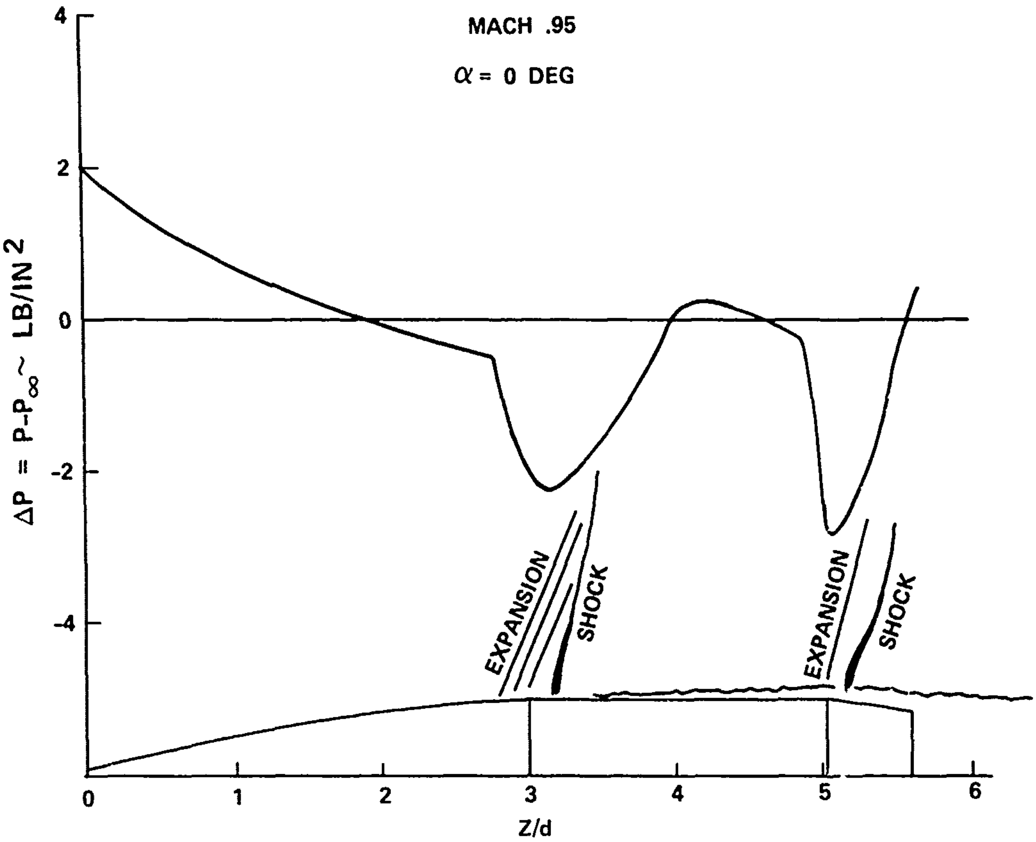


Figure 3. Transonic Flow Field and Surface Pressure Distribution

3. MODEL DESCRIPTION

The external model configuration and model sting arrangement are shown in Figures 4 and 5, respectively. The model was composed of a 3 caliber secant ogive, a 2 caliber cylindrical section, and a 7-degree, 0.5-caliber boattail. The projectile represents a 130-percent scale model of the M549/XM785 155-mm artillery projectile; however, it closely resembles the baseline projectile shape being analyzed by the BRL. The model also included the flat nose and wrench grooves of a standard fuze. The model's external shaping and scale were also identical to the model used in the Langley tests. The aft end of the model sting was attached directly to the wind tunnel roll head assembly which, in turn, was attached to the tunnel angle-of-attack sector sting.

A schematic drawing of the model's internal arrangement is shown in Figure 6. Detailed engineering drawings of the model components are included for your convenience in the last appendix in this report (Appendix D). The model consisted of an aluminum core containing the spin motor, pressure taps, and scanivalve mechanism. The model core was stationary (i.e., non-spinning) with respect to the model sting. The steel shell, representing the outer contour of the projectile was attached to the core by means of front and rear bearings and connected to the spin motor through an axial drive shaft at the nose. A set of four vent holes at 90-degree circumferential intervals were located through the shell at each of 20 longitudinal stations along the model. These vent holes which were 0.0625 inch in diameter coincided with the 20 pressure taps contained in the outer surface of the core section. Only two taps are shown in Figure 6 for clarity.

Two scanivalves, located in the core, were used as switching devices to allow the remote selection and engagement of the pressure tap seal units. The scanivalves were simultaneously driven by a common index/drive unit, also located in the model core. One scanivalve directed pneumatic air to a particular pressure tap seal unit to force it outward against the inner surface of the spinning shell. Concurrently, the other scanivalve directed the surface pressure being measured at that tap out through the sting to the pressure transducer and associated recording equipment located outside the tunnel. Figures 7 and 8 contain photographs of the model core with the shell removed to illustrate the scanivalve installation and the pressure tap locations, respectively.

The gap between the face of the pressure tap seal unit and the inner surface of the shell was sealed by means of a circular o-ring located on the outer face of the seal unit. The cavity created by engaging the seal unit with the shell was open to the pressure acting on the outside surface of the shell when the vent hole was aligned with the seal unit, as illustrated in Figure 9. Once the vent hole in the spinning shell rotated past this aligned position, the o-ring caused the cavity to retain the pressure. After a sufficient number of shell revolutions, the cavity eventually assumed a constant pressure equal to the pressure acting on the surface of the spinning shell at that particular circumferential location. Details of the pressure tap seal units are contained in Figure 10, and a photograph of them is shown in Figure 11. Figure 12 depicts the seal units installed in the boattail section of the core. The outer surface of each seal unit was contoured to match the radius of the inner shell surface at that location. The Parker-Hannifan No. 2-204-N827-80 o-rings, 0.5 inch diameter, were composed of lubricant-impregnated carboxylated nitrile rubber and were retained in the circular groove of the seal block by high viscosity silicone

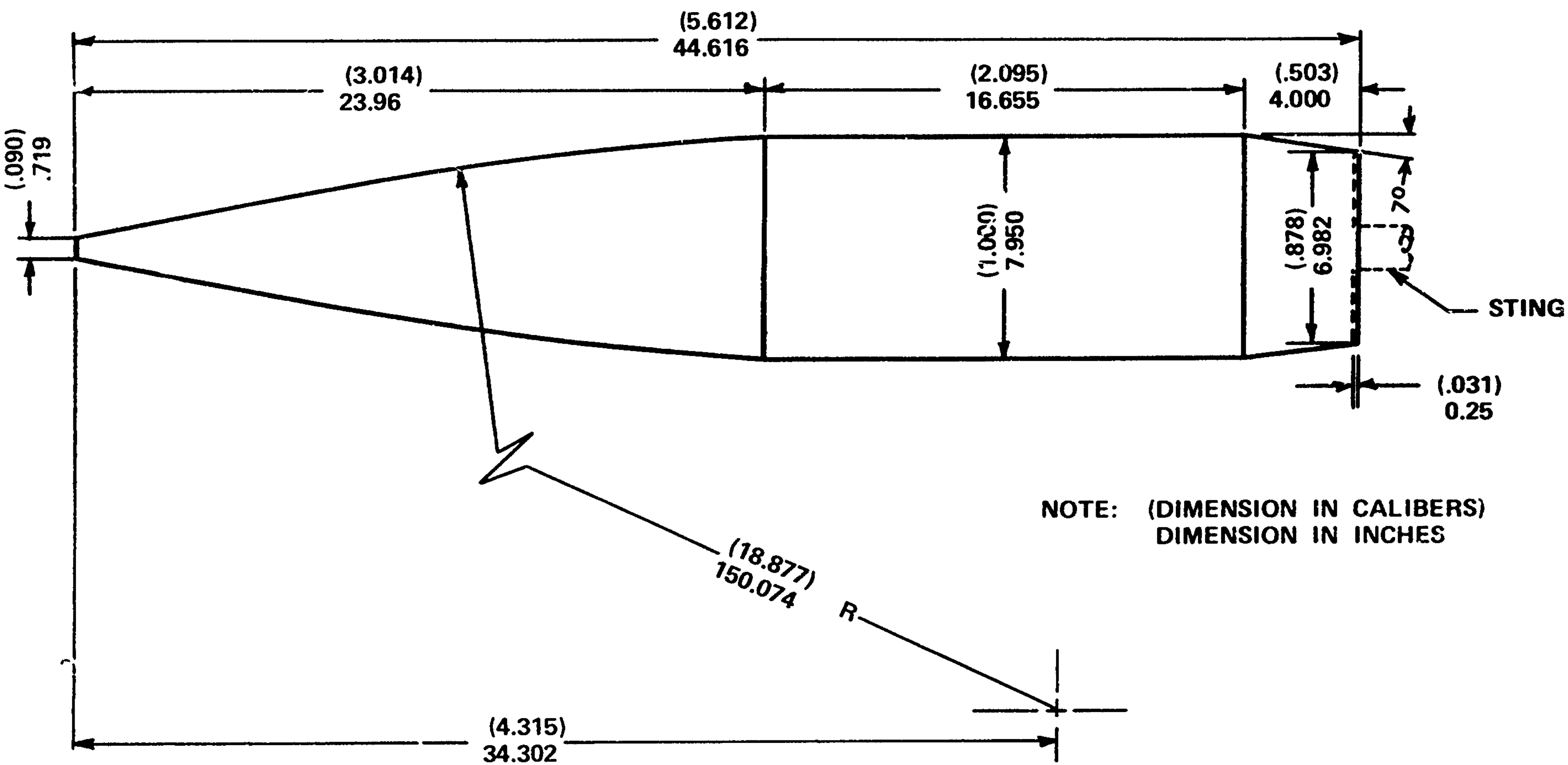


Figure 4. External Configuration of the Wind Tunnel Model

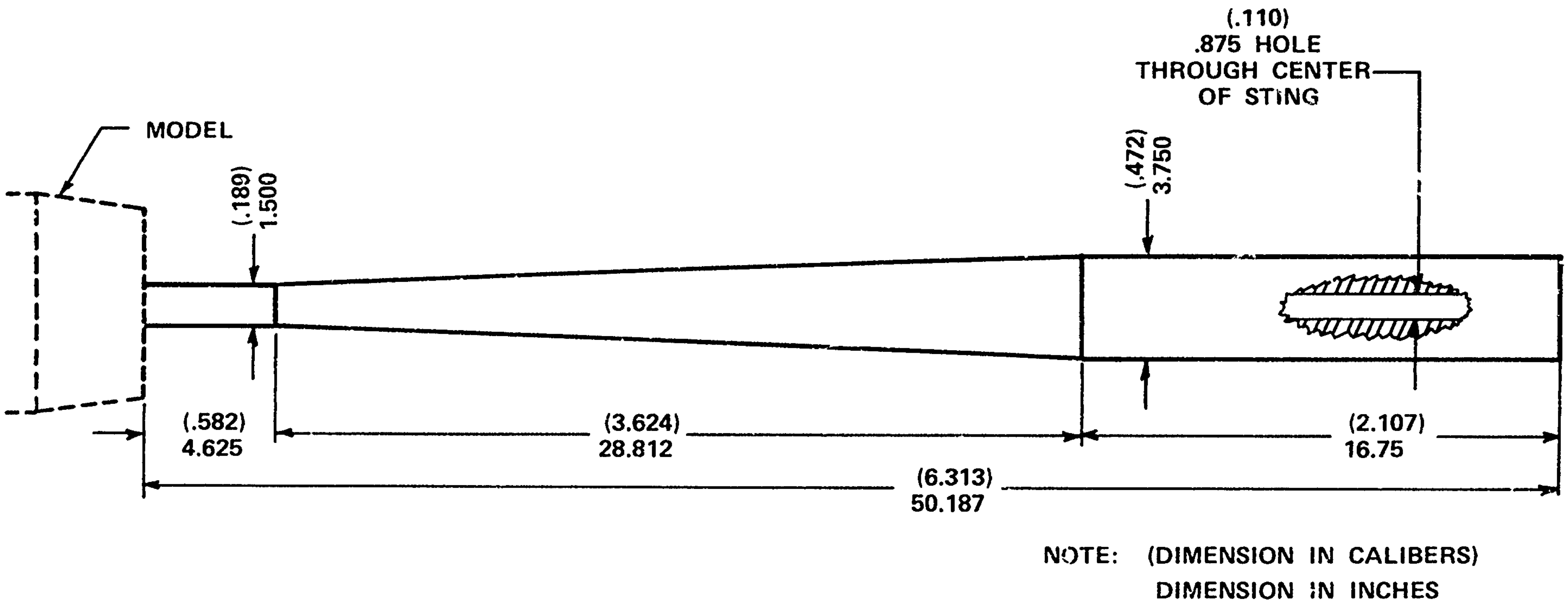


Figure 5. Sting Arrangement for the Wind Tunnel Model

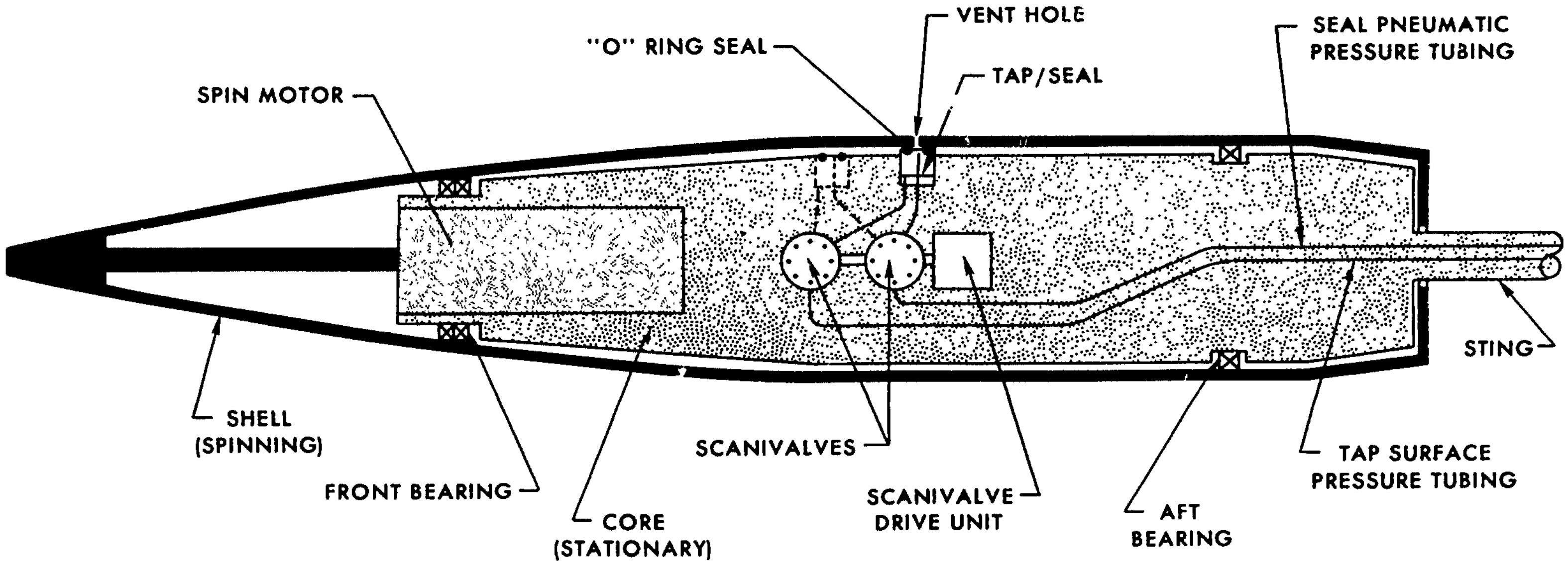


Figure 6. Internal Configuration of the Wind Tunnel Model

Figure 7. Photograph of the Model Core Showing Scanivalve Installation

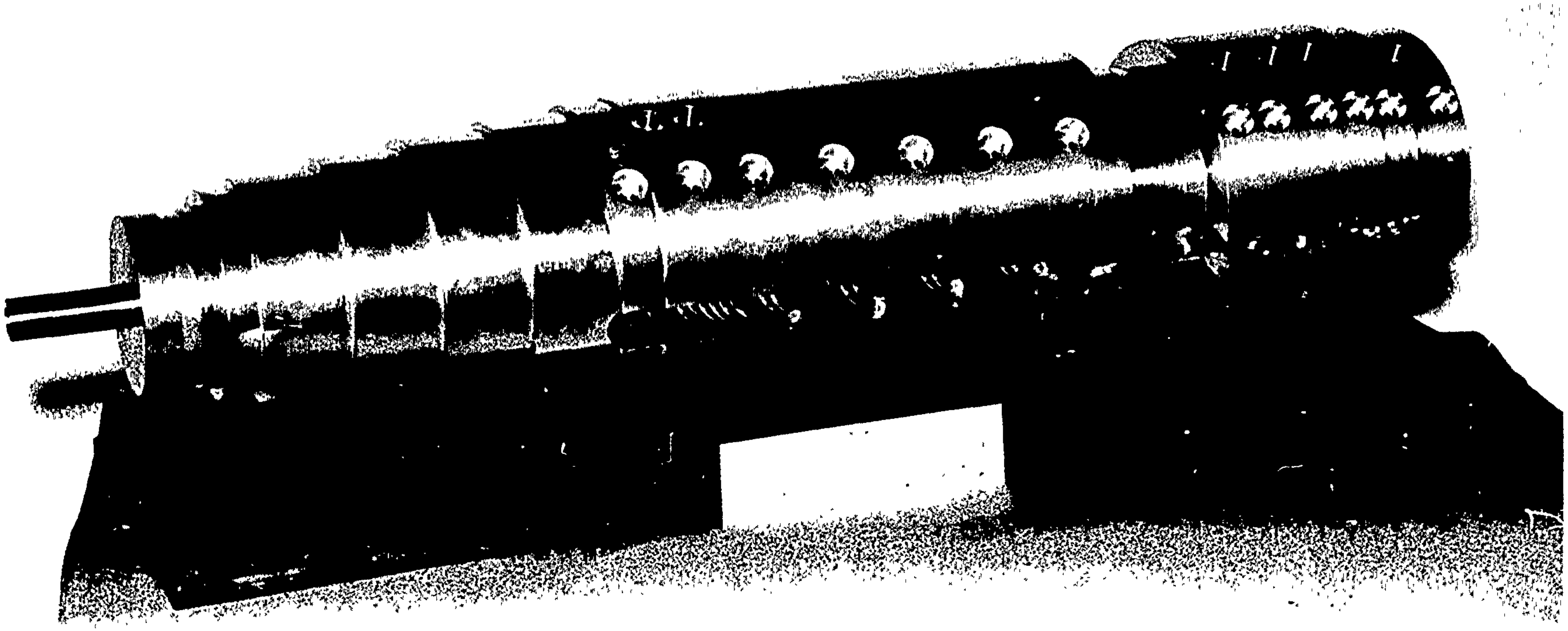


Figure 8. Photograph of the Model Core Showing Pressure Tap Locations

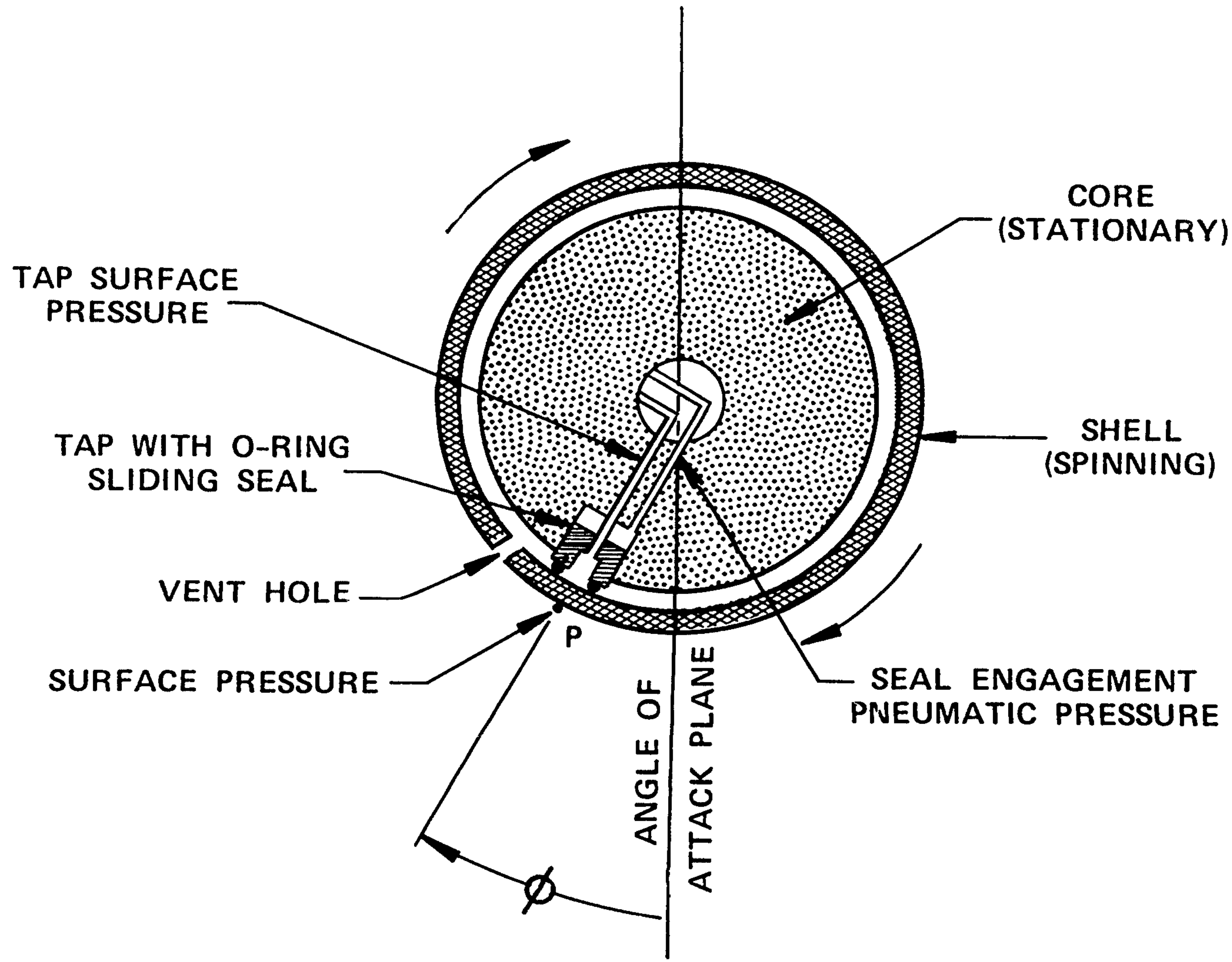


Figure 9. Surface Pressure Measurement Technique

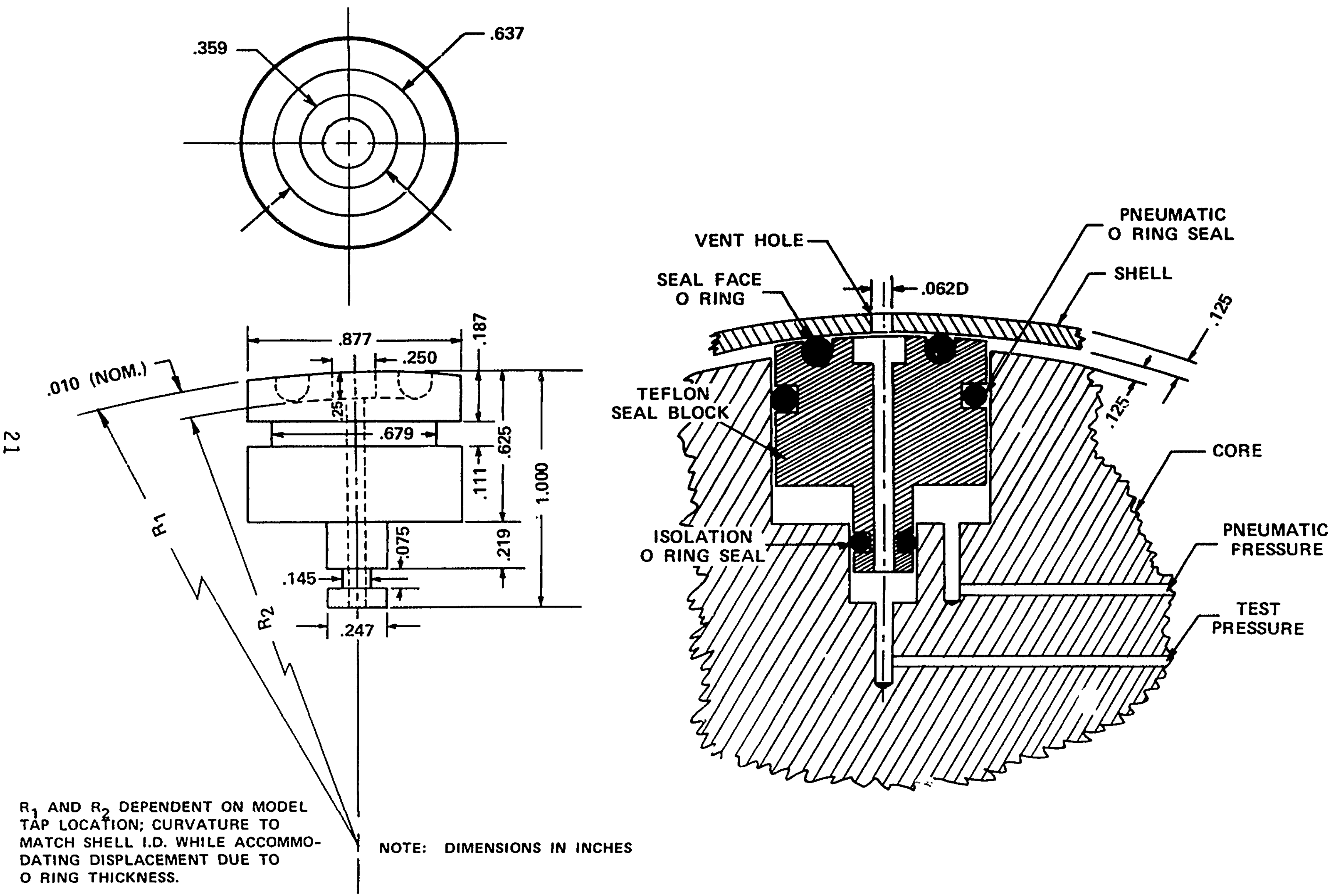


Figure 10. Details of the Pressure Tap Seal Unit

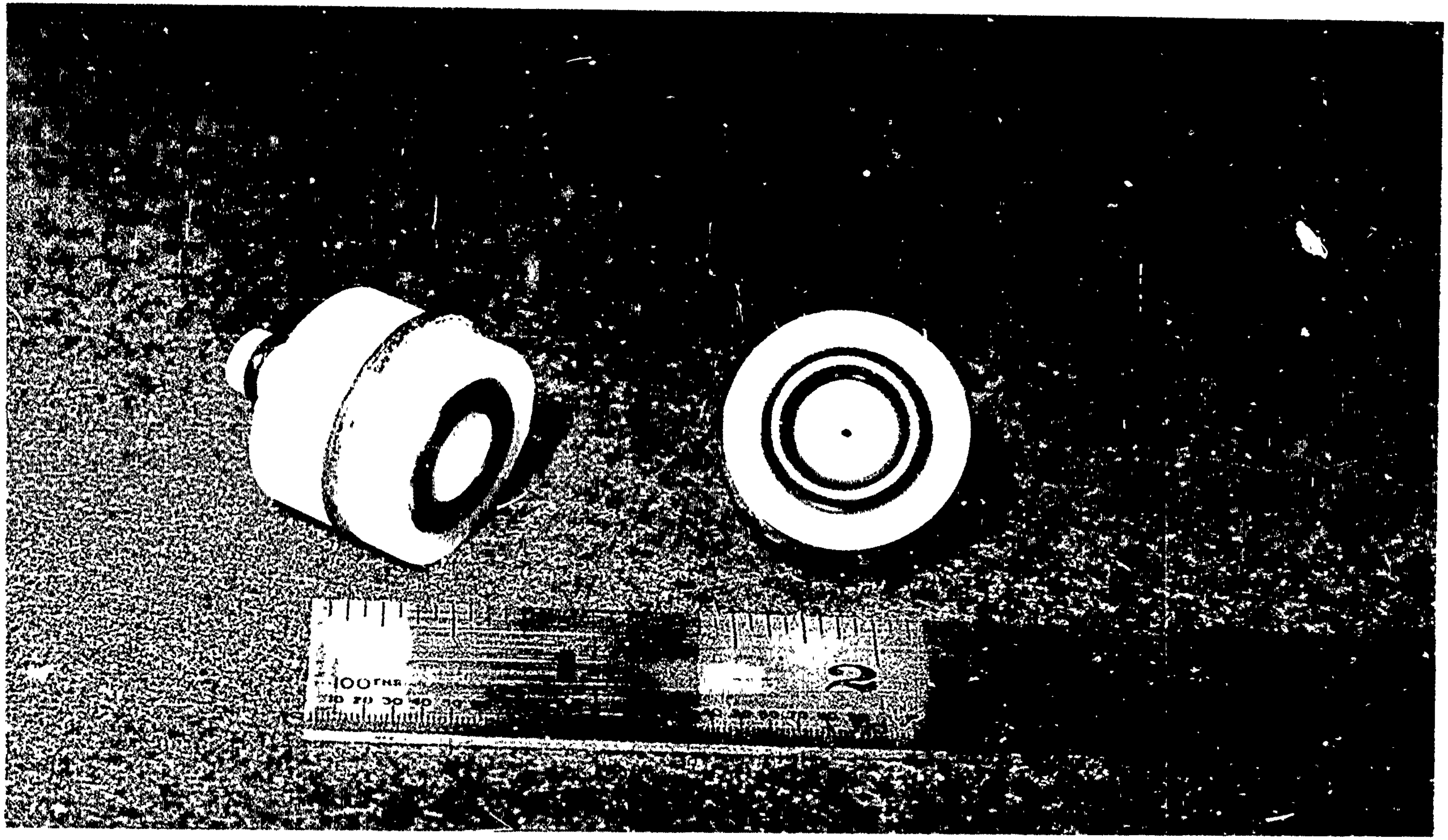


Figure 11. Photograph of Pressure Tap Seal Units

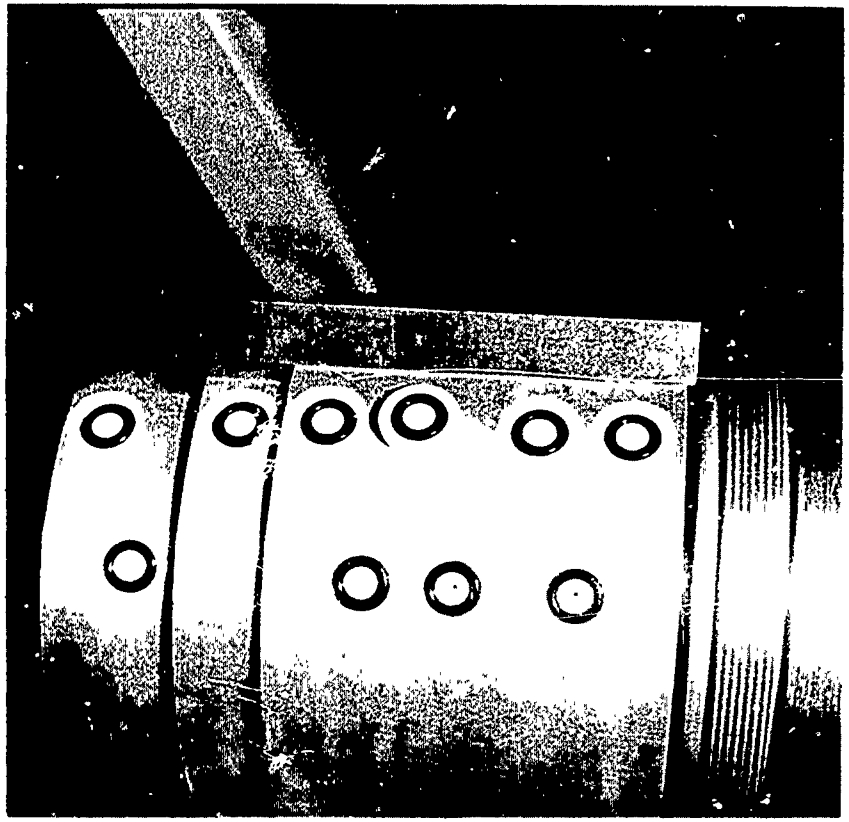


Figure 12. Photograph of Model Boattail Section of Core Showing Installed Pressure Tap Seal Units

oil. Pressure measurements at various points on the surface of the spinning body were obtained by positioning the core and the attached tap to different roll attitudes relative to the angle-of-attack plane. This was accomplished by means of a remotely settable roll head located between the model sting and the tunnel angle-of-attack sector sting. The roll head allowed the model core to be sequentially set to various roll orientations.

The steel shell was made up of two basic parts. The forward part included the ogive and most of the cylindrical section. The aft part included the boattail and the portion of the cylindrical section in the area of the rotating band. The model could be tested with or without the rotating band by simply changing the aft part of the shell. Figure 13 shows the aft shell section that included the rotating band. The rotating band, which represented a post-fired condition, was machined directly into the aft shell section. Vent holes were also located on the rotating band lands and grooves, allowing measurements at these positions. The model included an enclosed base similar to the actual projectile.

The longitudinal locations of the pressure taps for the 20 vent holes are defined in Figure 14. The tap locations were selected to match those used in the non-spinning surface pressure model used in the Langley tests. Some taps were offset 30 degrees to the main line of taps to allow closer longitudinal spacing than could be achieved with the seal units in a single line. The taps were concentrated over the cylindrical and boattail portion of the model because the Magnus effect primarily occurs in this area. Also, the flow over the ogive and the resultant small Magnus effect can be analyzed quite accurately by current theoretical means. One tap was located to measure the surface pressure on the base of the model at a radial location .09 calibers in from the edge of the boattail. Detailed drawings of the model and sting components are included in Appendix D.

All operation and instrumentation wiring and tubing were routed from the model to a special console located outside the tunnel test section through a hole .875 inch in diameter located down the length of the model sting. This hole contained the operating wires, thermocouple wires, and the cooling water tubing for the motor, the scanivalve operating wires, the engagement pneumatic pressure tubing and signal pressure tubing for the taps, and the thermocouple wires for the model bearings. The instrumentation and operating interfaces are detailed in Figure 15. The water-cooled, variable frequency/variable voltage electric motor was rated at 5 hp for the nominal 5,000 rpm model spin rate. This condition was easily achieved with 150 V/150 cps obtained from the tunnel generator system. The motor operated at about 10 amps and the motor temperature never exceeded 100 °F even after sustained operation of up to 8 hours. Model spin was smooth and, once established, never varied more than 50 rpm from the nominal 4,900 rpm. Engagement of a pressure tab seal unit reduced the spin rate about 100 rpm. Model bearing temperatures never exceeded 100 °F even under sustained spinning for several hours with the tunnel operating at a stagnation temperature of 130 °F. The model had no perceivable pitch or yaw motion during the test and possessed no vibration under all conditions of spin and angles of attack. During this test, the model was spun at 5,000 rpm for a total of 55 hours. Even after these 16,500,000 revolutions, the model bearings appeared to be as good as new. A photograph of the model installed in the wind tunnel test section is shown in Figure 16. The model core weighed 100 pounds, the model shell, 65 pounds, and the model sting, 85 pounds.

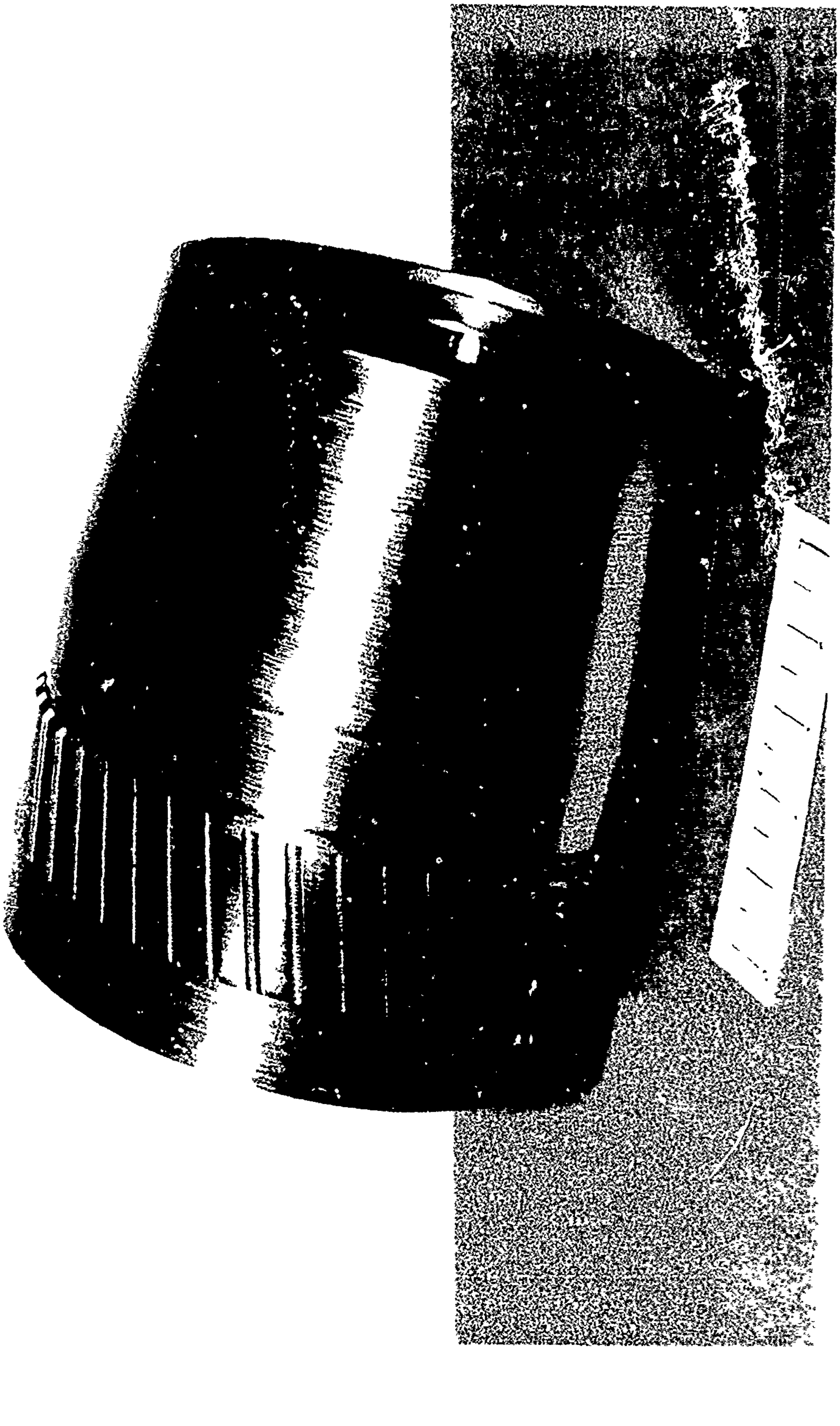
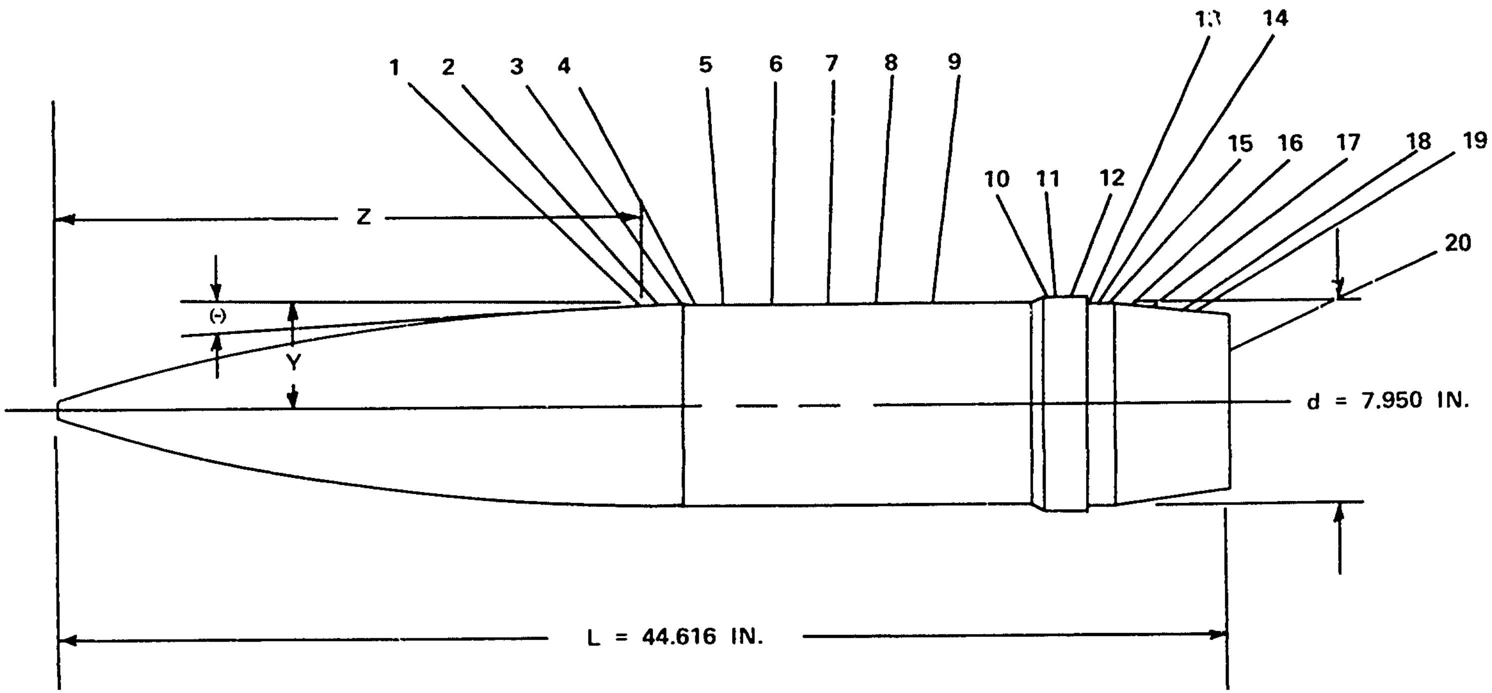


Figure 13. Photograph of Boattail Section of Model Shell

TAP NO.	Z (IN.)	Z/L	Z/d	Y (IN.)	Y (Y/d)	Θ DEG	TAP LOCATION NOTES	TAP CIRCUMFERENTIAL LOCATION WRT MAIN TAPS (DEG)
	TAP LOCATION							
1	22.449	.503	2.824	3.875	.487	4.5	OGIVE	0
2	23.450	.526	2.950	3.969	.499	4.5	↓	30
3	23.961	.537	3.014	3.975	.5	0	OGIVE/CYLINDER JUNCTION	0
4	24.461	.548	3.077	3.975	.5	0	CYLINDER	30
5	25.461	.571	3.203	3.975	.5	0	↓	0
6	27.461	.615	3.454	3.975	.5	0	↓	↓
7	29.461	.660	3.706	3.975	.5	0	↓	↓
8	31.461	.705	3.957	3.975	5	0	↓	↓
9	33.461	.750	4.209	3.975	.5	0	↓	↓
10	37.821	.848	4.757	3.975	.5	0	ROTATING BAND	0
11	38.321	.859	4.820	3.975	.5	0	↓	30
12	38.821	.870	4.883	3.975	.5	0	↓	0
13	39.616	.888	4.983	3.975	.5	0	CYLINDER	30
14	40.116	.899	5.046	3.975	.5	0	↓	0
15	40.616	.910	5.109	3.975	.5	0	CYLINDER/BOATTAIL JUNCTION	30
16	41.151	.922	5.176	3.938	.495	7.0	BOATTAIL	0
17	42.159	.945	5.303	3.813	.425	7.0	↓	0
18	43.236	.969	5.438	3.688	.480	7.0	↓	30
19	43.725	.980	5.500	3.625	.456	7.0	↓	0
20	44.616	.994	5.578	2.750	.346	90°	BASE	90



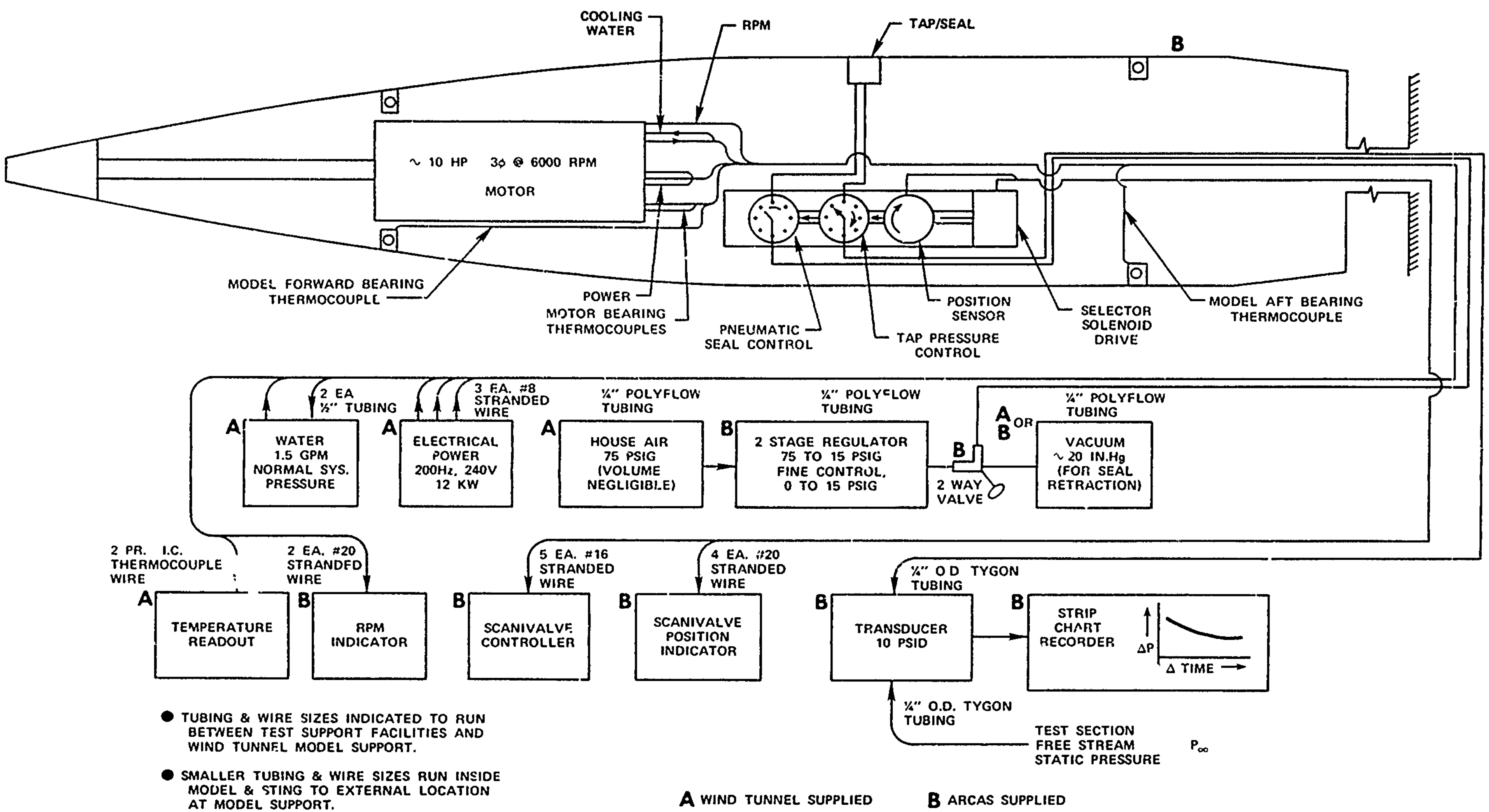


Figure 15. Details of Model Operation and Instrumentation Interfacing

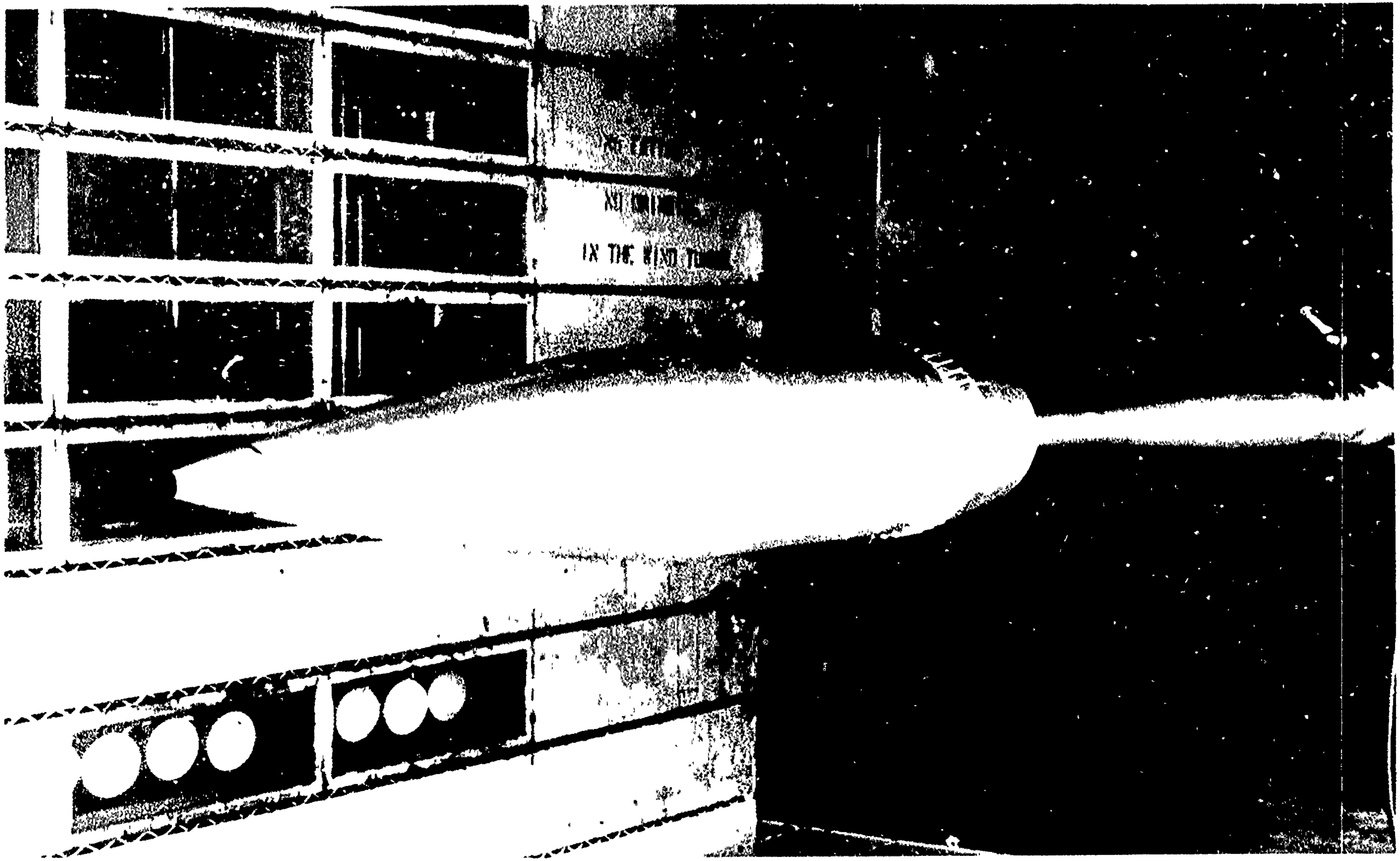


Figure 16. Photograph of Model Installed in 14-Foot Transonic Wind Tunnel

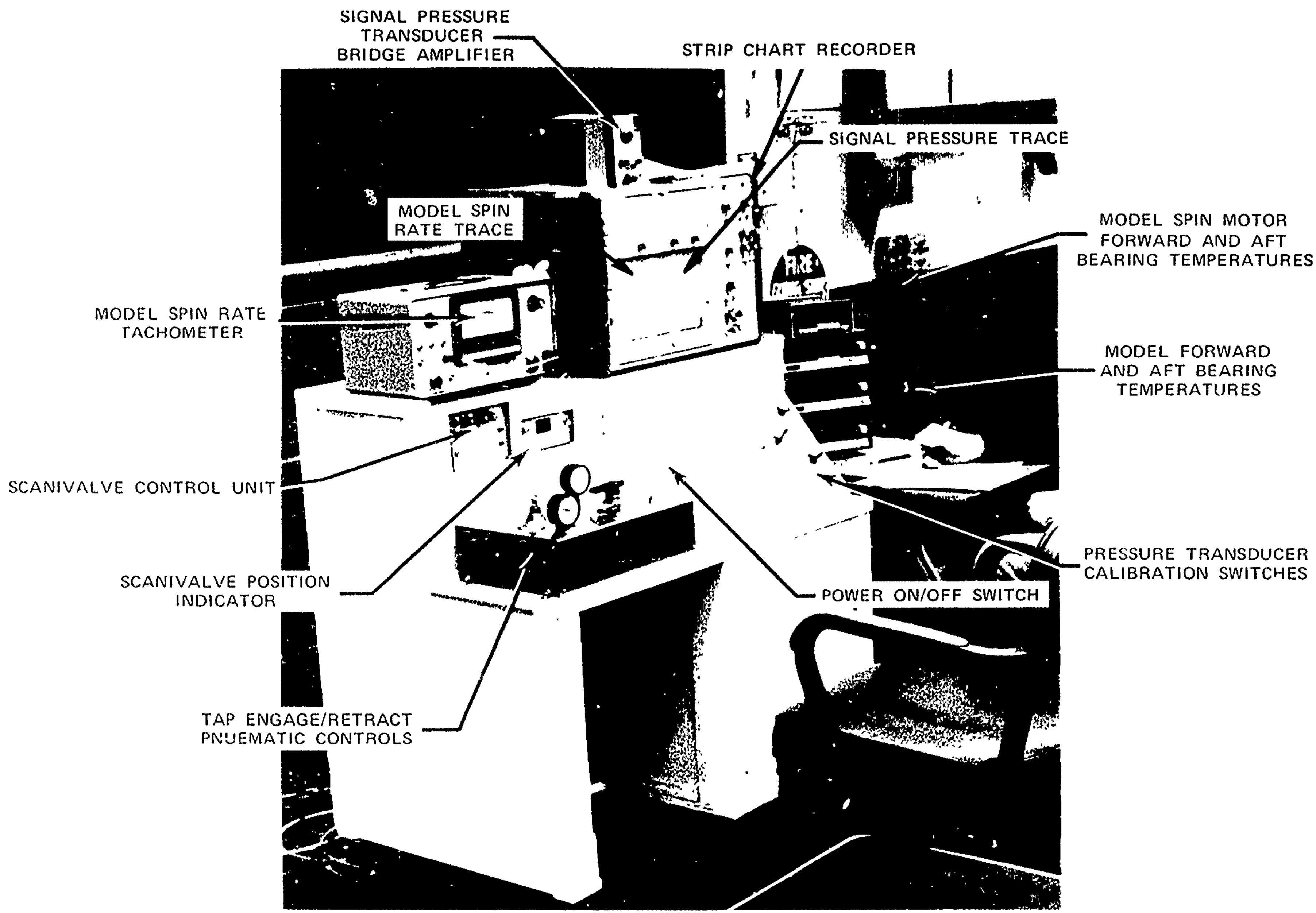
Figure 16. Continued

The special console, shown in Figure 17, was located in the tunnel control room and contained the single differential pressure transducer used to measure the surface pressure of the model with respect to the test section's free stream static pressure. The strip chart recorder continuously displayed the output of the pressure transducer as a function of time, thereby allowing the quality of the data to be assessed as testing proceeded. The console included the capability to remotely zero and calibrate the transducer while the tunnel was operating. Pressure tap selection, engagement, and disengagement were accomplished by controls located in the console. The model rotational speed and critical model bearing temperatures were also monitored with instrumentation located on the control console. Changes in the angle of attack, roll head movement, and model spin motor operations were controlled by wind tunnel personnel. Calibration of the roll angle of the model core was done by machining an indexed flat surface on the model sting. This surface was aligned with the primary row of model pressure taps as the zero degree reference. A clinometer placed on the flat allowed model roll alignment to within 1 minute of arc.

4. TEST PROCEDURE

The wind tunnel test program is summarized in Figure 18. All testing was done at a Mach number of 0.94. The model was tested at angles of attack of 0, 4, and 10 degrees for model spin rates of 0 and 4,900 rpm. Because of the constant circumferential pressure distribution for the runs at 0 degree angle of attack, pressures were measured at 45-degree increments of roll, resulting in eight readings per longitudinal location. For the runs at 4 and 10 degrees angle of attack, pressures were measured every 10 degrees of roll, resulting in 36 readings per longitudinal location. Due to time constraints, data for the model with the rotating band were only taken at 0 and 10 degree angles of attack. Also, only the 12 rear most taps were used for the rotating band case because the presence of the band did not affect the forward pressures.

The test procedure was to establish the tunnel air flow at the test Mach number for a given model configuration and angle-of-attack condition. The model was spun up to the desired test spin rate. A single pressure tap seal unit was then remotely engaged by means of the scanivalve selector, which directed high-pressure air to the tap location. A pneumatic pressure of about 5 psi was sufficient to force the designated tap o-ring out against the inner surface of the model shell to provide the sliding seal function. The engaged pressure tap was then able to detect the surface pressure at that location. When the pressure was visually determined to be constant from the strip chart recorder, the wind tunnel data acquisition system recorded the value, reduced it to coefficient form, and printed it out along with the tunnel conditions at that time. The model core was then rotated to the next circumferential position by means of the remotely controlled roll head and the procedure repeated until a complete circumferential circuit was completed. Figure 19 presents a portion of the strip chart record. About 60 to 90 seconds were required for the measured pressure to reach its constant equilibrium value. This pressure was directed through the second scanivalve and down the model support sting via plastic tubing to the pressure transducer located in the data recording console. At the completion of a circumferential circuit, the tap was disengaged and the next tap engaged. Engagement and disengagement of seals could be accomplished remotely while the model was spinning and the tunnel operating.


SIGNAL PRESSURE TRANSDUCER BRIDGE AMPLIFIER
STRIP CHART RECORDER
SIGNAL PRESSURE TRACE
MODEL SPIN RATE TRACE
MODEL SPIN MOTOR FORWARD AND AFT BEARING TEMPERATURES
MODEL SPIN RATE TACHOMETER
MODEL FORWARD AND AFT BEARING TEMPERATURES
SCANIVALVE CONTROL UNIT
PRESSURE TRANSDUCER CALIBRATION SWITCHES
SCANIVALVE POSITION INDICATOR
POWER ON/OFF SWITCH
TAP ENGAGE/RETRACT PNUEMATIC CONTROLS

WIND TUNNEL TEST PROGRAM
NASA AMES 14-FT TRANSONIC TUNNEL
TEST NO. 463, 8 FEB 83 - 6 MAR 83

					PRESSURE READINGS			
SERIES NUMBER	ROTATING BAND	MACH NO.	ANGLE OF ATTACK (DEG)	SPIN RATE (RPM)	LONGITUDINAL LOCATIONS	CIRCUMFERENTIAL LOCATIONS	CIRCUMFERENTIAL INCREMENTS	RUN NUMBER
1	OFF	.94	0	0	20	8	45^o	7-11, 12-25
2				-4,900				73-92
3			4	0		36	10^o	30-49
4				-4,900				98-112
5			10	0				113-122, 127-135
6				-4,900				50-69
7	ON		0	0	10	8	10^o	144-154
8				-4,900				181-192
9			10	0		36	10^o	157-168
10				-4,900				169-180

*NOTE: 1) SPIN RATE CORRESPONDS TO pd/2V OF .162 FOR 7.95 INCH DIAMETER MODEL.

2) NOMINAL TEST SECTION CONDITIONS: $T_o = 130^oF$, $R_d = 4x10^6/FT$, $q = 743\ LB/FT^2$, $P_\infty = 8.35\ LB/IN^2$

Figure 18. Wind Tunnel Test Program

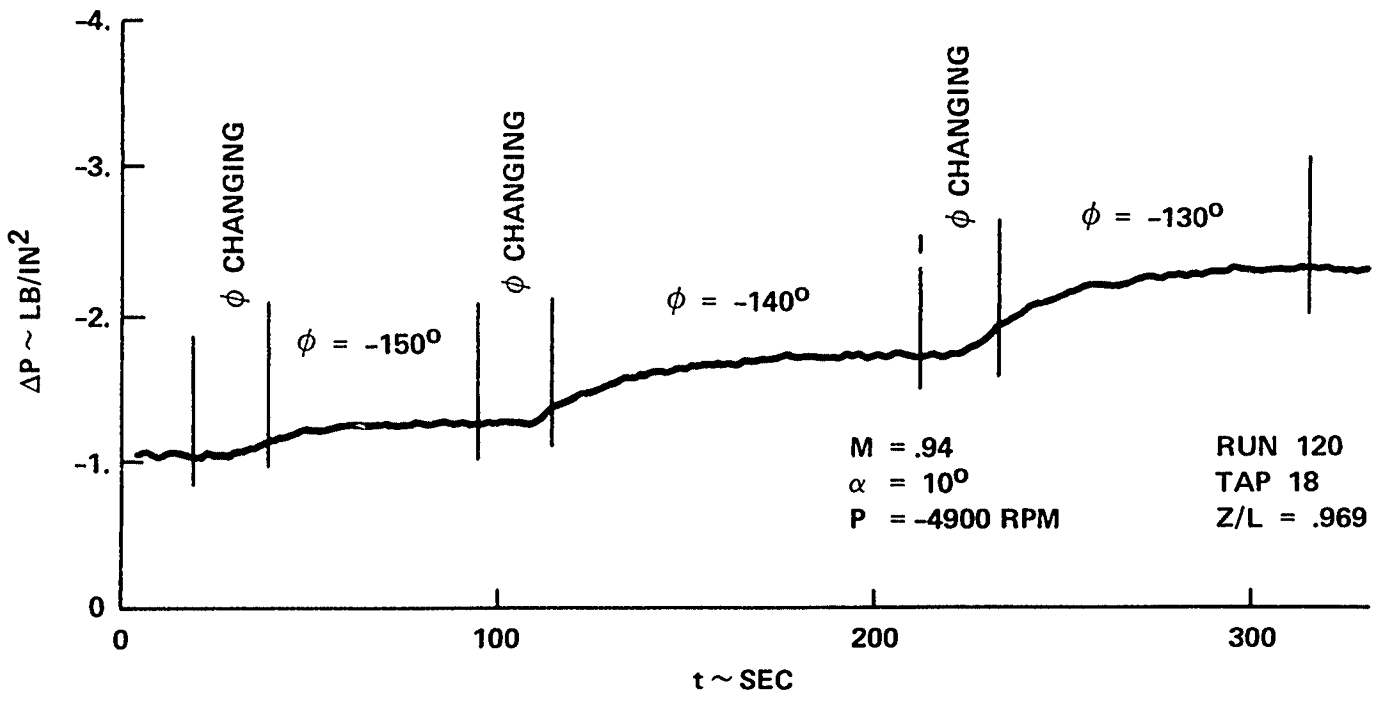


Figure 19. Typical Surface Pressure Measurements

The relatively long time required for the pressure to become constant was due to the 150-foot length of tubing between the model and the transducer. This resulted in seal engagement times of about 40 minutes to complete a circumferential survey at a particular longitudinal location. Over 12 hours were needed to test a single model configuration. Locating the transducer in the control room had several advantages, such as ease of calibration, absence of temperature effects, and the provision of pressure pulse damping volume. With the test method validated, in future use of this technique, the transducer could be located in the model or in the sector sting with a marked reduction in tube length, pressure lag time, and consequent data acquisition time.

After each spinning test, the shell was removed and the o-rings changed. In most cases, the o-rings showed little or no wear. In fact, one seal was engaged for over 75 minutes without experiencing any detectable wear. However, certain tap locations did produce severe o-ring wear, as noted in Table 1. For the non-spinning tests, the model shell was simply locked to the core by a set screw with the vent holes aligned with their respective taps. This allowed the shell and core to be rotated together by the roll head. Certain operational difficulties were encountered during the initial portion of the test. When fully retracted, the seal blocks would cover the pneumatic port, reducing the effective base area over which the engaging air pressure could act. Also, in the retracted position, the clearance between the seal block and the inside diameter of the shell was great enough to occasionally allow an o-ring to escape from its groove in the seal block. Both problems were effectively eliminated by placing a wire ring with a 0.30-inch diameter beneath the seal block. This prevented the base of the seal block from covering the pneumatic pressure port and reduced the clearance between the shell and seal so that the o-ring could not be dislodged from its groove in the seal block. It was found that 600,000 CS silicone fluid could be used to help retain the o-rings in their grooves. Following an o-ring change, each seal was sequentially engaged and the shell manually rotated back and forth to mate the contour of the seal with the internal contour of the shell to ensure seal engagement and alignment with the inside surface of the shell. The seals were then retracted prior to starting of the test run.

5. ANALYSIS OF RESULTS

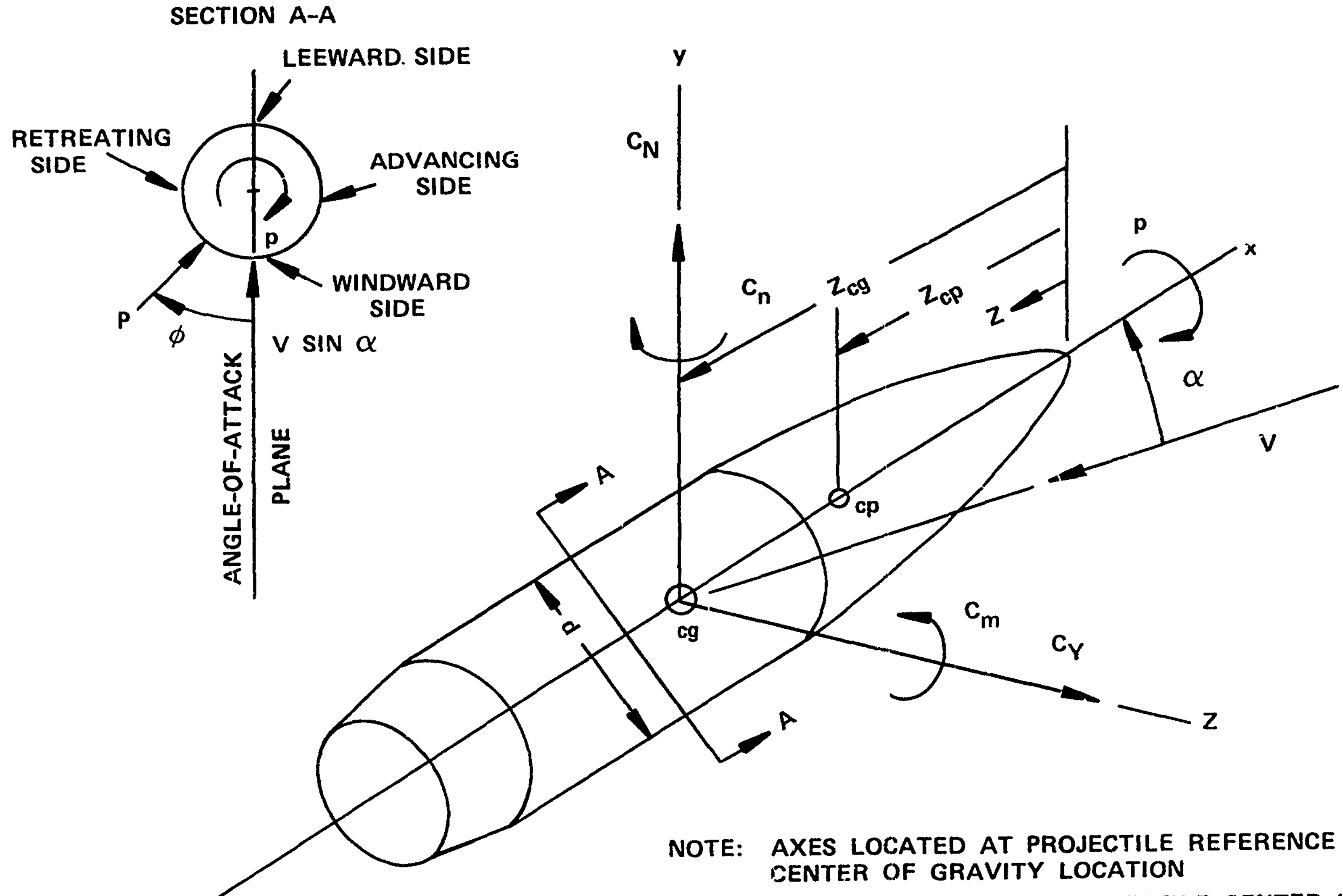
5.1 General.

The surface pressure data were reduced to coefficient form as defined in Figure 20. All of the wind tunnel data are tabulated in Appendix A, which lists the pressure coefficient measured at each circumferential and longitudinal location for a particular test run. The data are also provided in plotted form in Appendix B. The differential pressures measured and the associated pressure coefficients are plotted as a function of circumferential angle for each longitudinal tap location. Each set of data is presented for a specific model configuration for both the spinning and non-spinning cases. These data are available for use in evolving or validating theoretical or computational fluid dynamic analyses of the Magnus effect.

The following sections include examples of specific effects and observed phenomena obtained during this test.

Table 1. Summary of O-Ring Wear During Test

RUN	TAP NO.	ROTATING BAND	α (DEG)	COMMENTS
81	9	OFF	0	GREASE BLACKENED AROUND SOME SEALS, NO NOTICEABLE WEAR ON ANY O RINGS, DATA APPEARED OK
92	20	↓	↓	
93	1	↓	4	O RING HAD SOME SURFACE SCRATCHES
102	10	↓	↓	O RING BADLY WORN, DATA ERRATIC
127	1	↓	10	O RING WORN
144	14	ON	↓	O RING WORN, O RING MATERIAL TRANSFERRED TO SHELL
145	15	↓	↓	O RING WORN, O RING MATERIAL TRANSFERRED TO SHELL
146	16	↓	↓	O RING WORN, O RING MATERIAL TRANSFERRED TO SHELL
152	10	↓	↓	O RING BAD
153	11	↓	↓	O RING WORN
164	16	↓	0	O RING WORN
165	17	↓	↓	O RING WORN
166	18	↓	↓	SEALBLOCK STEM BROKEN, ALLOWING PNEUMATIC AND TEST PRESSURES TO COMMUNICATE



NOTE: AXES LOCATED AT PROJECTILE REFERENCE CENTER OF GRAVITY LOCATION

x - AXIS LIES ALONG PROJECTILE CENTER LINE

y - AXIS IS NORMAL TO x - AXIS AND LIES IN ANGLE-OF-ATTACK PLANE

z - AXIS IS NORMAL TO ANGLE-OF-ATTACK PLANE

Figure 20. Definition of Terms

5.2 Surface Pressure Distribution.

Figure 21 shows the pressure measured along the projectile for an angle of attack of 0 degrees for both the spinning and non-spinning cases. Note that spin produces slightly reduced pressures at most locations. These data illustrate the ability of the testing method to accurately measure even these small pressure effects. During the test, pressure differences of .025 psi could be determined. The non-spinning data in Figure 21 show excellent agreement with the previous NASA-Langley test data.

Figure 22 contains circumferential surface pressure data at a point on the boattail under spinning conditions. The model was spun in a counter-clockwise direction (pilot's view) in order to provide a tightening effect on the right-hand threaded shell components. This negative spin resulted in a positive Magnus force as defined in Figure 16. Data are shown for two separate tests and illustrate the excellent repeatability obtained, even for the severe pressure variations present.

Figure 23 shows similar pressure data measured on another boattail location for the model spinning in opposite directions. These data illustrate that no asymmetric bias was present with the model or instrumentation. The Magnus effect is clearly illustrated in Figure 24, which shows the difference in the circumferential pressure distribution due to spin. A net negative pressure difference is produced on the retreating side of the projectile and a positive pressure difference on the advancing side, resulting in an additive effect to the Magnus force. These data indicate that spin produces both a circumferential shift as well as a distortion of the non-spinning pressure distribution.

The effect of angle of attack on the circumferential surface pressure distribution at a point on the boattail under spinning conditions is shown in Figure 25. Note that the pressure asymmetry that produces the Magnus force is most pronounced at the largest angle of attack. The resultant local force in the angle-of-attack plane denoted by C_{N_i} (computed by integrating the circumferential pressure distribution) does not change with angle of attack for this location. However, the resultant force normal to the angle-of-attack plane C_{Y_i} (i.e., the Magnus force) increases nonlinearly with angle of attack. These data also illustrate the presence of a negative pressure "hump" on the advancing side of the leeward point of the projectile (ϕ = 140 degrees). This effect is present at all longitudinal locations for the spinning projectile at an angle of attack of 10 degrees, as illustrated in Figure 26, but does not occur at an angle of attack of 4 degrees. This hump may be due to the presence of an attached vortex on the leeward side of the projectile at the larger angle of attack.

5.3 Force and Moment Distribution.

The circumferential pressure distributions were integrated to determine the resultant normal force (in the angle-of-attack plane) and side force (normal to the angle-of-attack plane) at each longitudinal tap location. These local forces are presented in coefficient form as C_{N_i} and C_{Y_i}, respectively as defined in Figure 20. These coefficients indicate the detailed influence of the Magnus effect at various longitudinal positions on the projectile.

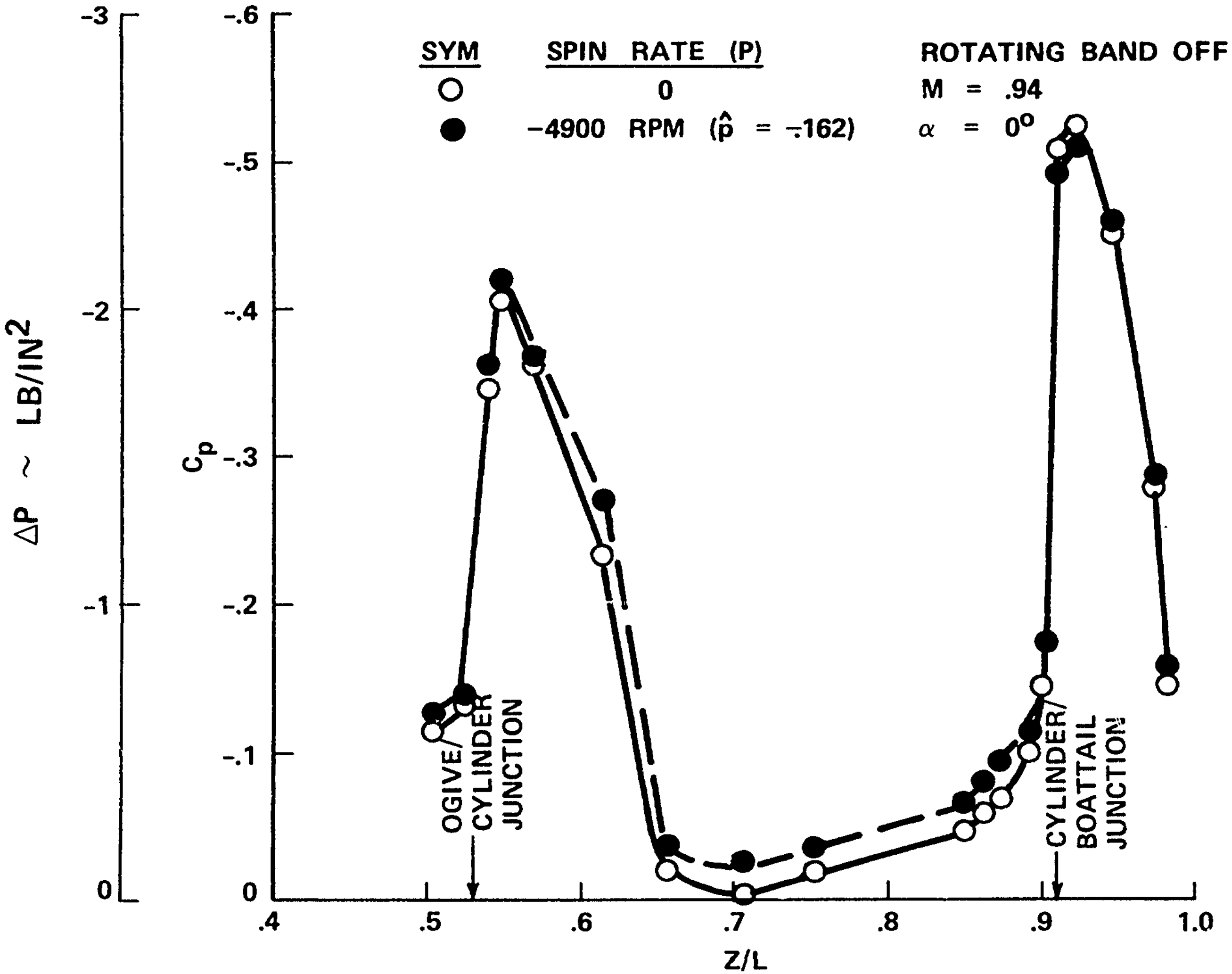


Figure 21. Effect of Spin on Longitudinal Surface Pressure Distribution for $\alpha = 0$ Degrees

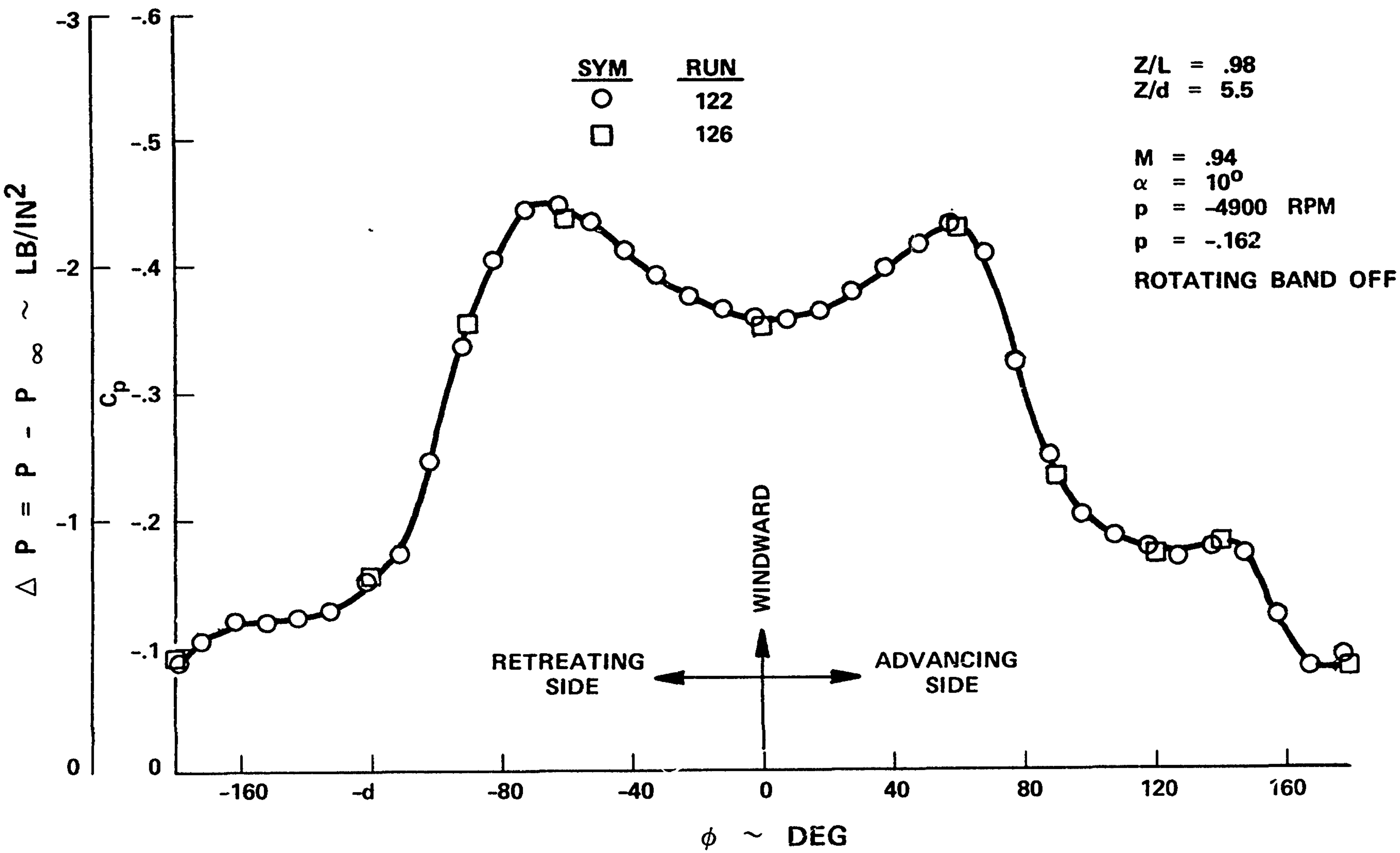


Figure 22. Circumferential Pressure Distribution on Boattail - Demonstration of Repeatability

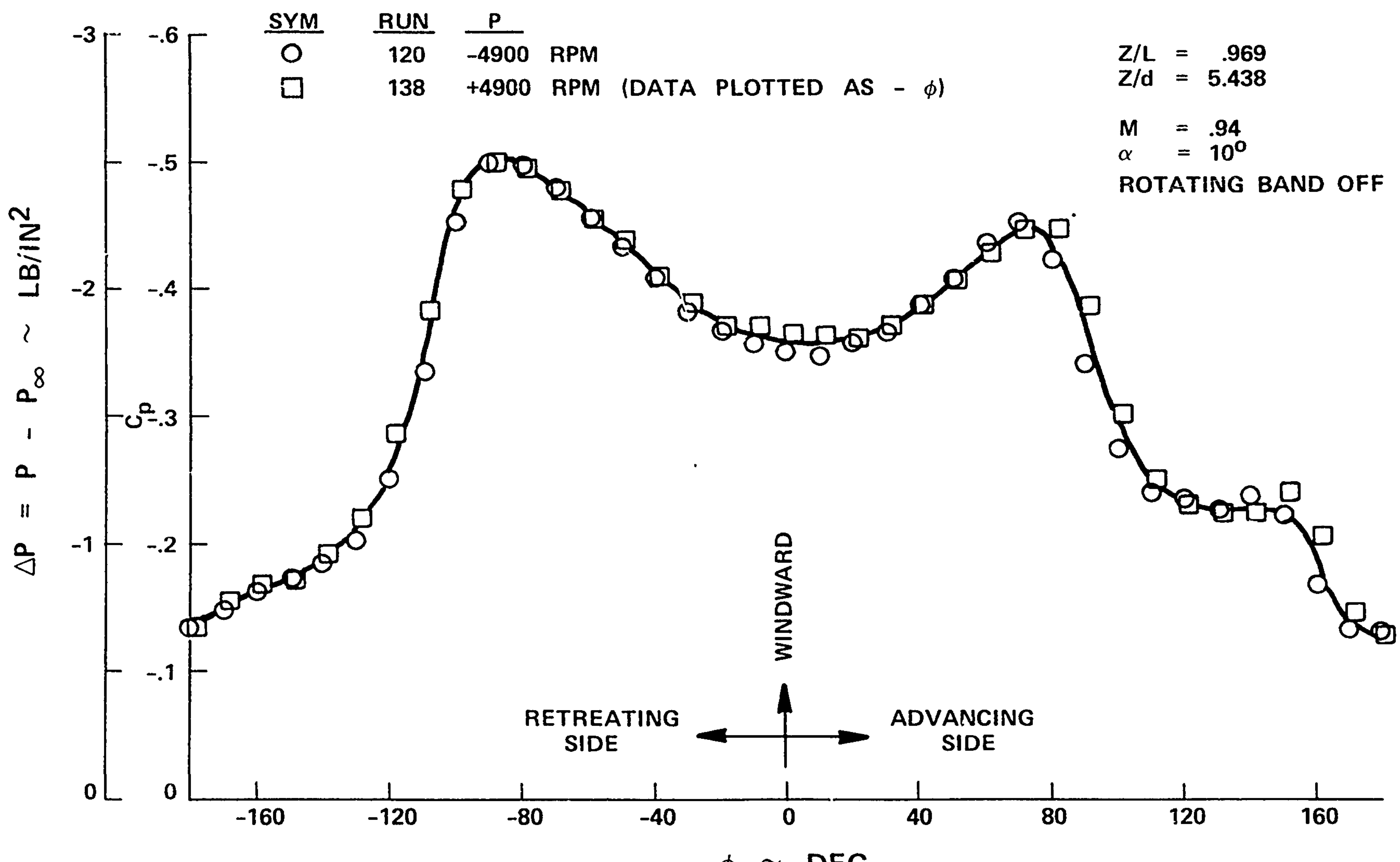


Figure 23. Circumferential Pressure Distribution on Boattail -

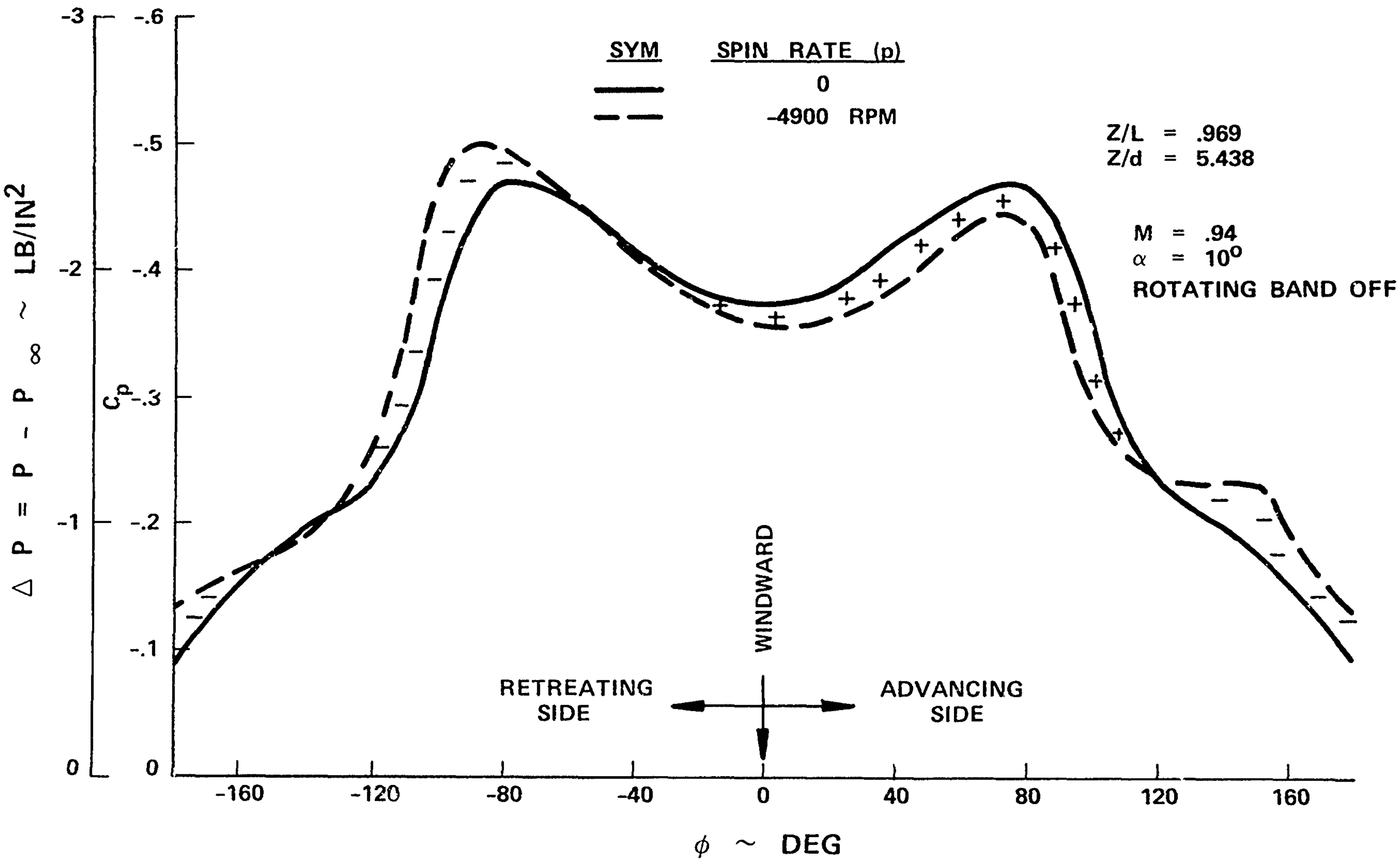
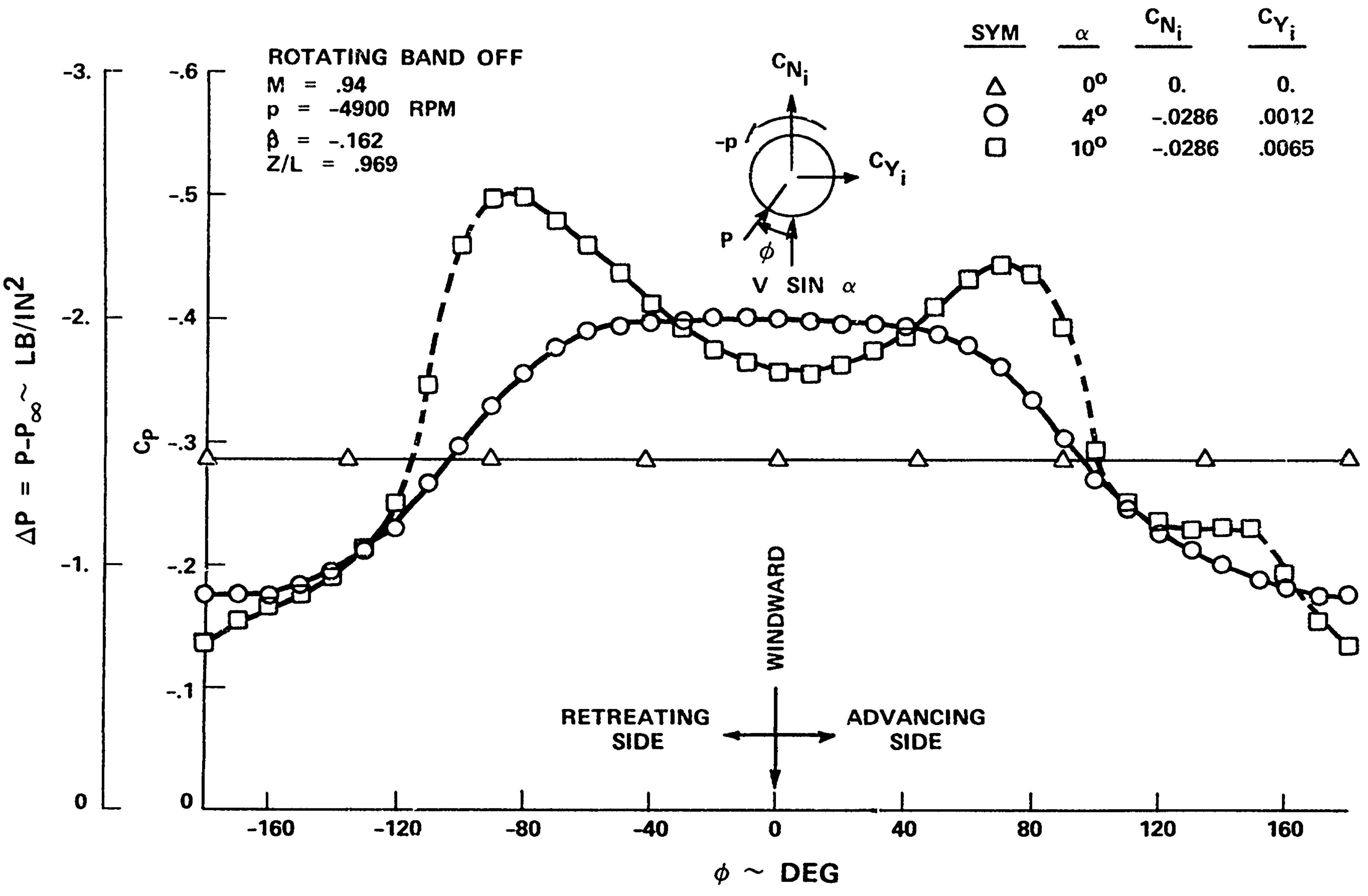


Figure 24. Effect of Spin on Boattail Circumferential Pressure Distribution


ROTATING BAND OFF
M = .94
p = -4900 RPM
β = -.162
Z/L = .969
SYM α C_{N_i} C_{Y_i}
△ 0° 0. 0.
○ 4° -.0286 .0012
□ 10° -.0286 .0065
C_{N_i}
C_{Y_i}
-p
p
ϕ
V SIN α
WINDWARD
RETREATING SIDE
ADVANCING SIDE
$\Delta P = P - P_\infty \sim LB/IN^2$
C_P
$\phi \sim$ DEG

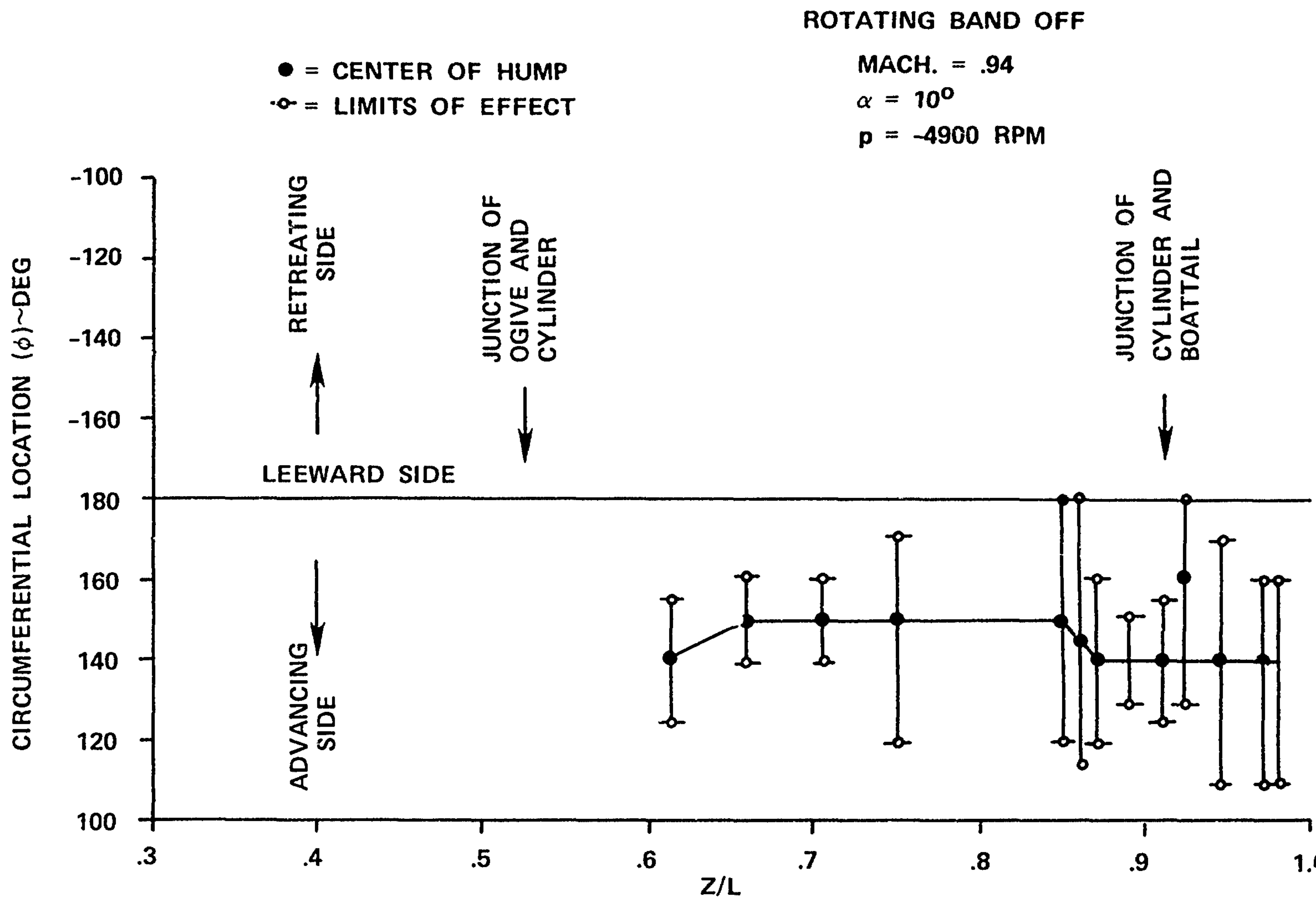


Figure 26. Circumferential Location of Negative Pressure Hump as a Function of Longitudinal Location (α = 10 Degrees)

The resulting normal and side force distributions are shown in Figures 27 through 29 for angles of attack of 0, 4, and 10 degrees, respectively. As expected, the Magnus-induced side force is significantly less than the normal force. Figure 30 shows the side force at an enlarged scale, indicating that the largest Magnus effect occurs over the boattail.

Although a net positive Magnus force results for both the 4 and 10 degree angles of attack, there are longitudinal regions on the projectile where the local Magnus force acts in a negative sense. For the 10-degree case, this situation only occurs in the vicinity of the shock waves; whereas for the 4-degree case, it is also present on the cylindrical section and at the aft portion of the boattail. Note that the greatest Magnus side force occurs on the cylindrical portion of the projectile for the 4-degree case and on the boattail for the 10-degree case. A particularly large Magnus side force is present on the boattail at a 10-degree angle of attack. This large Magnus force, in combination with the large moment arm between the boattail and projectile center of gravity, results in a significant Magnus yawing moment.

By integrating the local force coefficients in a longitudinal sense, the normal force and side (i.e., Magnus) force coefficients can be determined for each component (i.e., ogive, cylinder, and boattail), as well as for the total projectile. In a similar fashion, pitching moments and yawing (i.e., Magnus) moments can also be computed, as well as their respective centers of pressure. The moment terms are referred to a reference point representing the nominal center of gravity of the actual projectile located .625 calibers from the nose.

These terms are summarized in Appendix C and include the coefficient derivatives for force and moment with respect to angle of attack and nondimensional spin rates. The detailed derivations of the local normal and Magnus side force and their centers of pressure are also contained in Appendix C. The use of these derivatives both facilitate interpretation of the data and allow comparison with results from other studies. The relative contributions of the various projectile components to the Magnus force and moment terms depicted in Figure 30 are summarized in Table 2. These quantitative values further demonstrate the importance of the boattail in producing the Magnus effect.

The influence of spin on the normal force distribution for angles of attack of 0, 4, and 10 degrees is indicated in Figures 31 through 33. At both angles of attack, the presence of spin decreases the negative normal force acting on the forward portion of the cylindrical section of the projectile and decreases the positive normal force acting over the aft portion of the cylindrical section, which should result in a larger positive force and pitching moment for the spinning case.

The effect of angle of attack on the normal force and moment terms are contained in Table 3 for the non-spinning case and in Table 4 for the spinning case. Tables 5 and 6 show the effect of spin on the normal force and moment terms for angles of attack of 4 and 10 degrees, respectively.

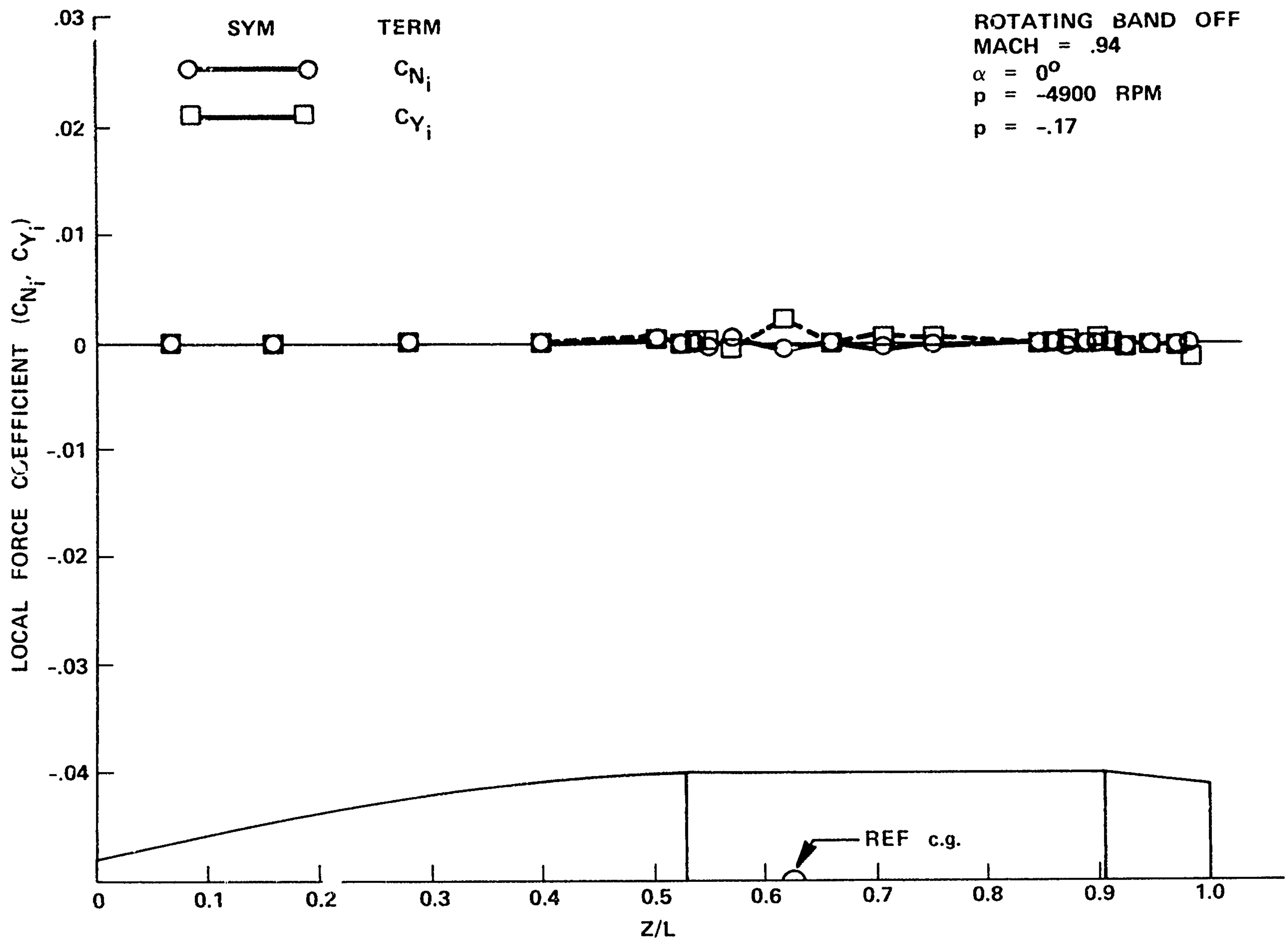


Figure 27. Normal and Side Force Longitudinal Distribution on Spinning Model
(α = 0 Degrees)

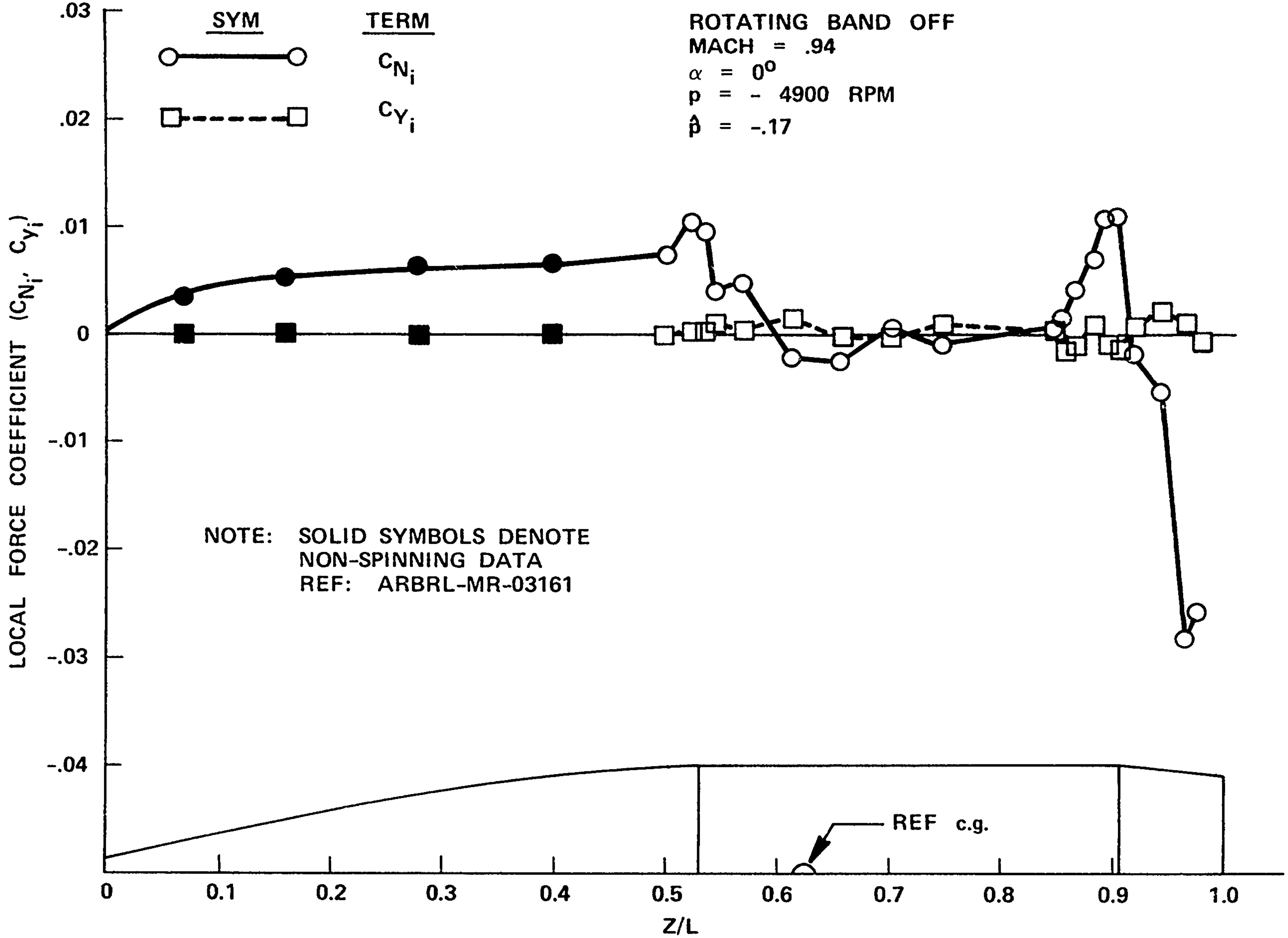


Figure 28. Normal and Side Force Longitudinal Distribution on Spinning Model
(α = 4 Degrees)

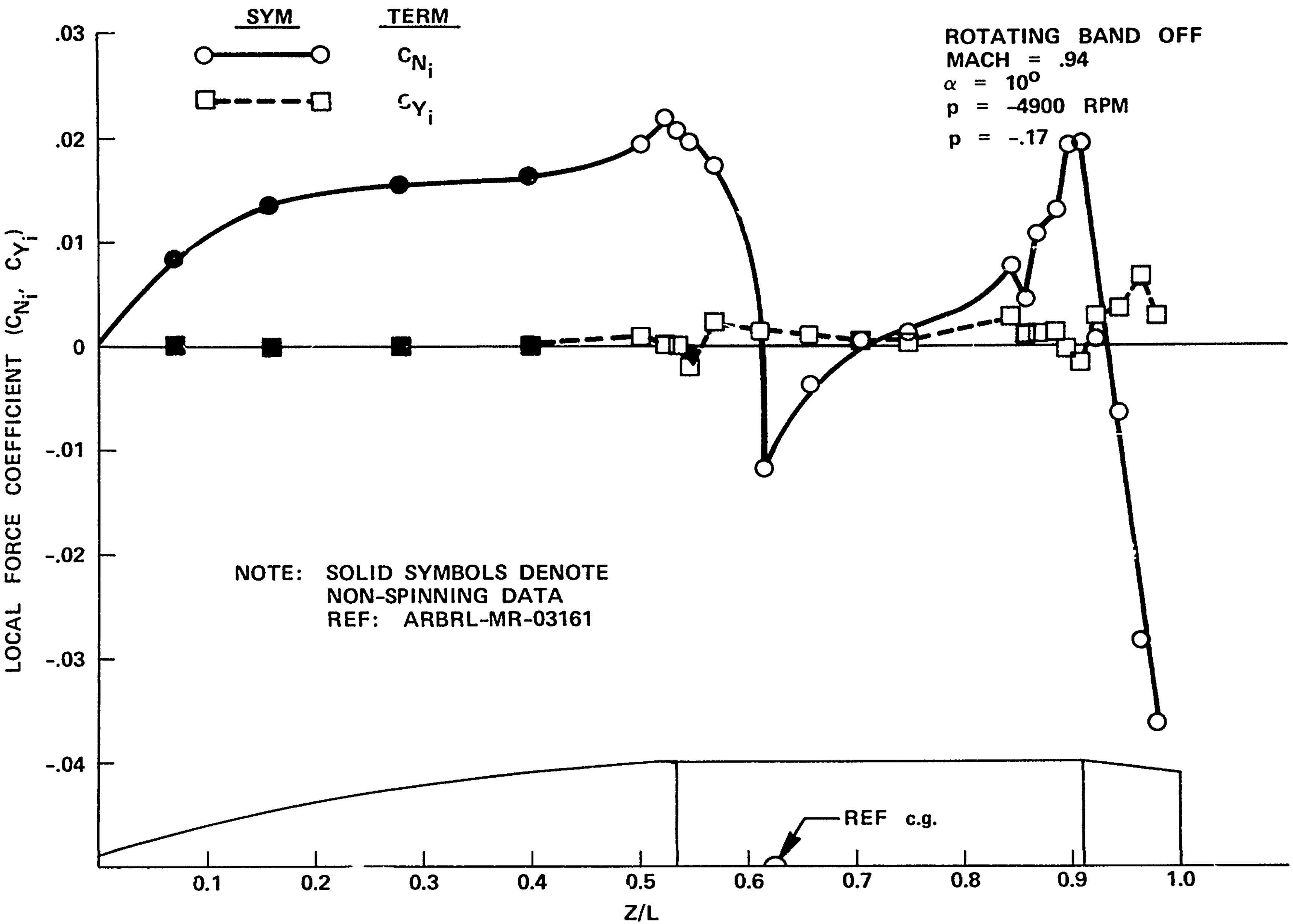


Figure 29. Normal and Side Force Longitudinal Distribution on Spinning Model
(α = 10 Degrees)

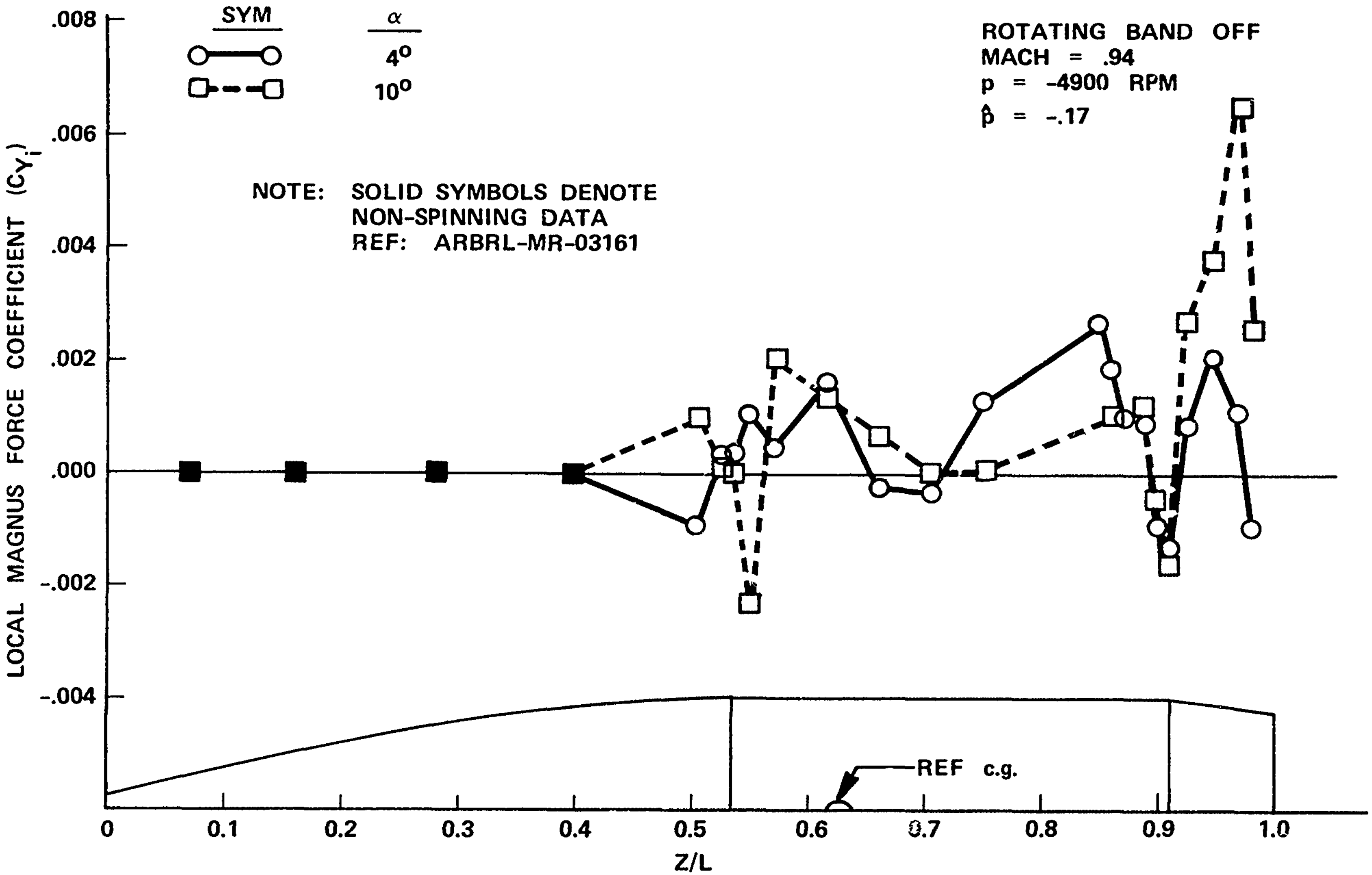


Figure 30. Side Force Longitudinal Distribution on Spinning Model for α = 4 Degrees and α = 10 Degrees

Table 2. Side Force and Moment Terms for α = 4 Degrees and α = 10 Degrees (Rotating Band Off)

MODEL CONFIGURATION: 3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL
ROTATING BAND OFF
$Z_{cg/L}$ = .625

TEST CONDITIONS: MACH .94
pd/2V = .162

TERM	$\alpha = 4^o$	$\alpha = 10^o$
C_{Y_p} (OGIVE)	.000	-.004
C_{Y_p} (CYLINDER)	-.085	-.092
C_{Y_p} (BOATTAIL)	-.019	-.080
C_{Y_p} (TOTAL)	-.104	-.176
C_{n_p} (OGIVE)	.000	-.003
C_{n_p} (CYLINDER)	.056	.063
C_{n_p} (BOATTAIL)	.033	.148
C_{n_p} (TOTAL)	.090	.208
$Z_{cp/L}$ (MAGNUS)	.779	.836

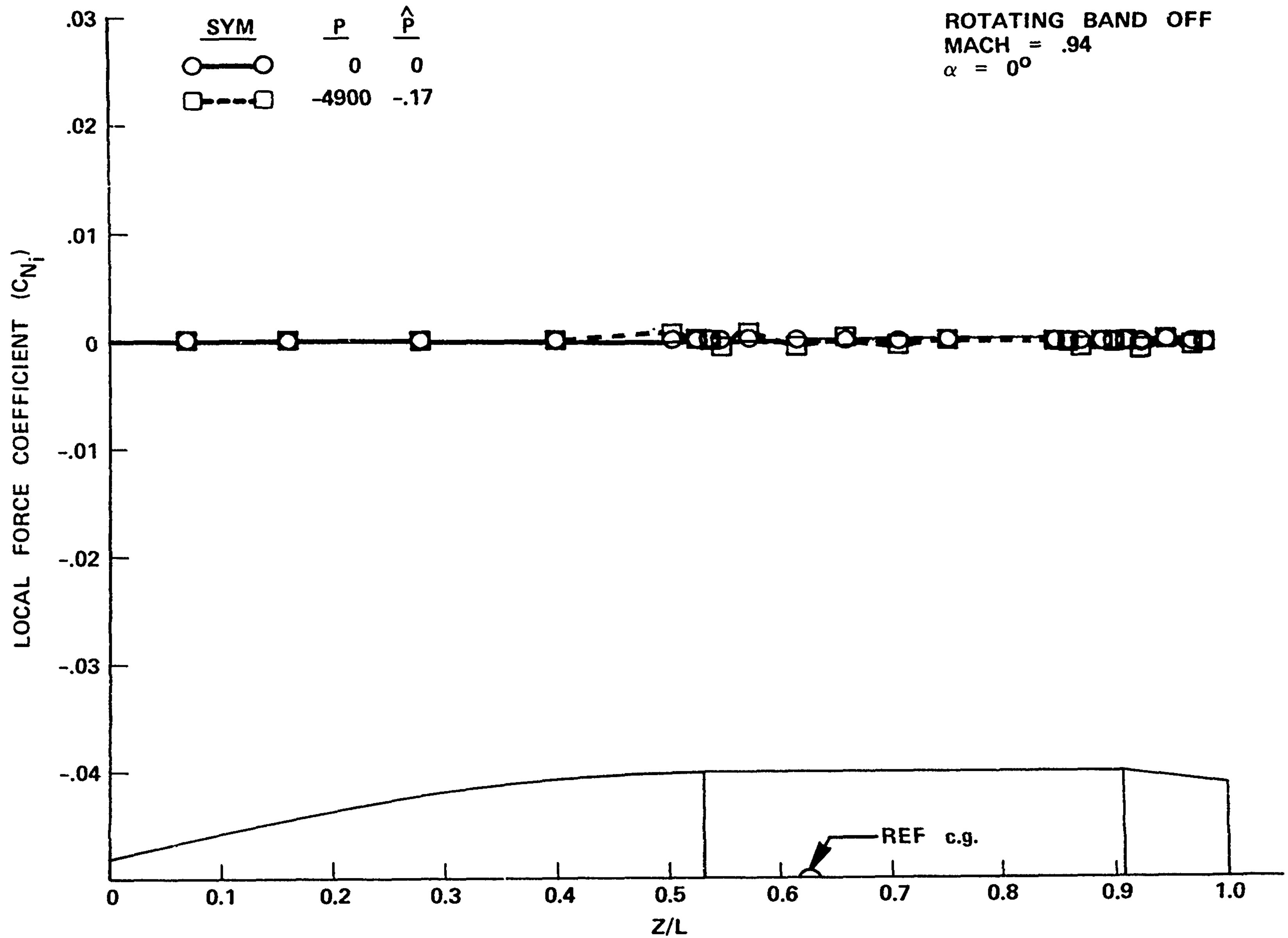


Figure 31. Effect of Spin on Normal force Longitudinal Distribution
(α = 0 Degrees)

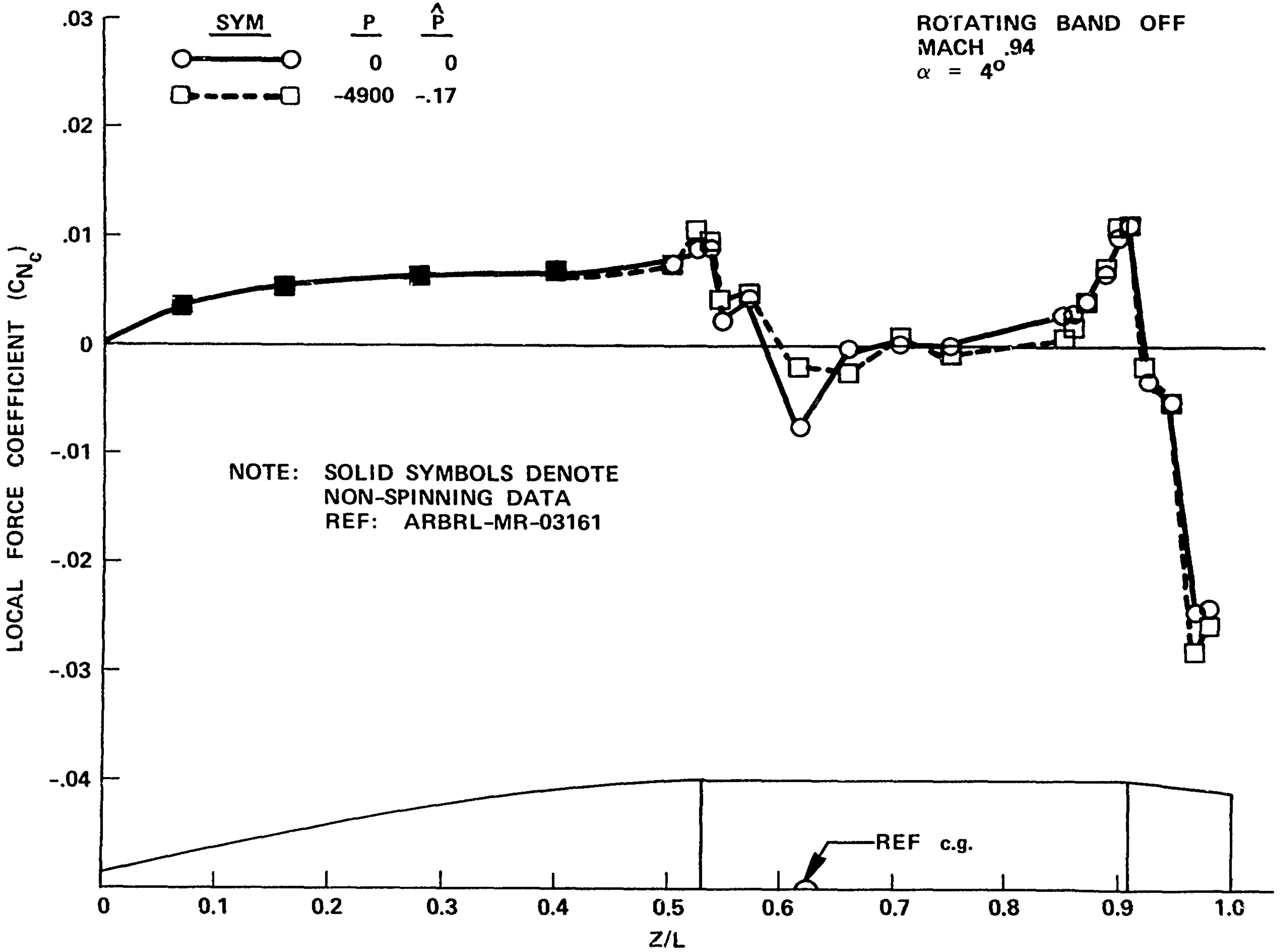


Figure 32. Effect of Spin on Normal Force Longitudinal Distribution
(α = 4 Degrees)

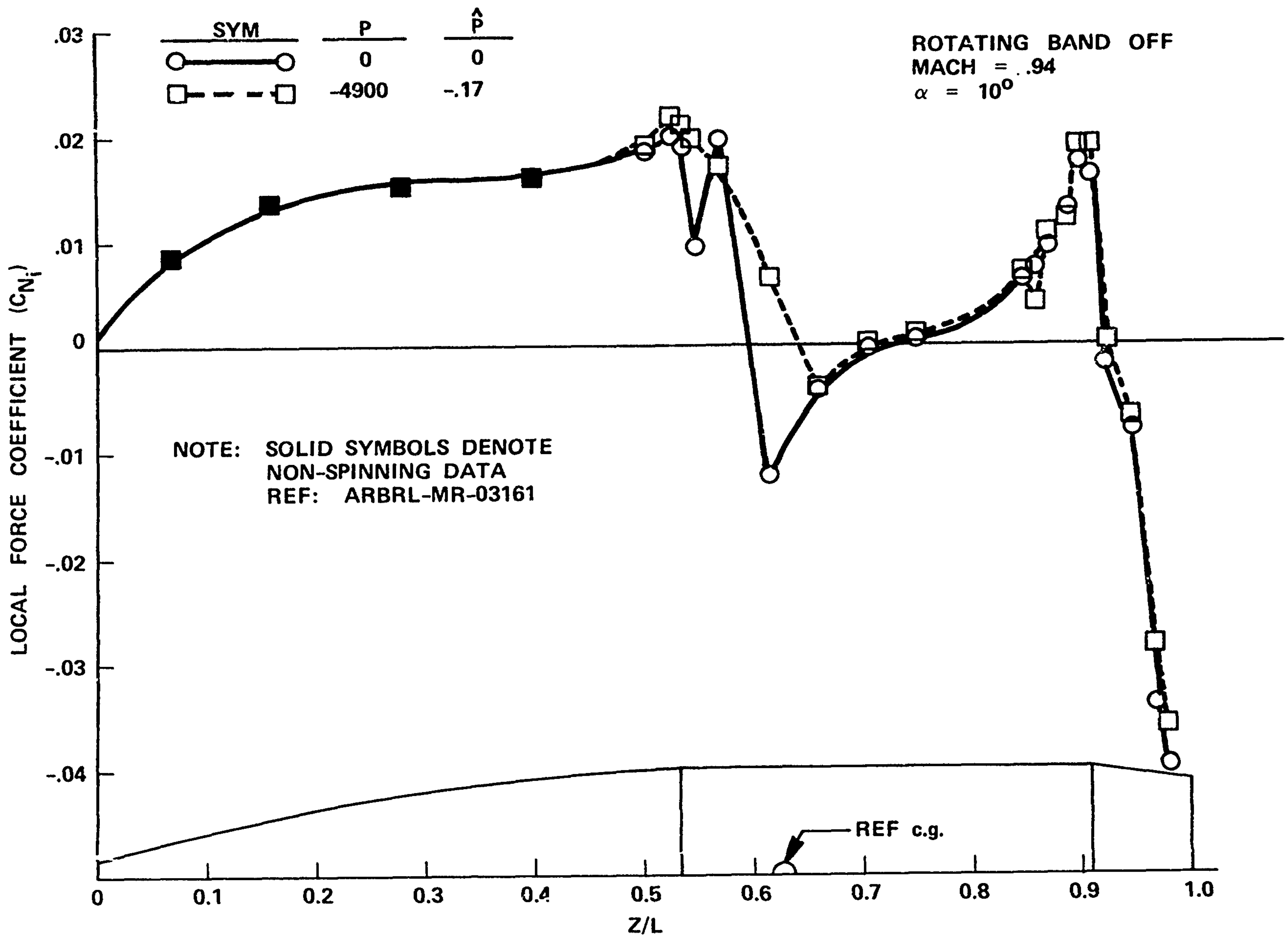


Figure 33. Effect of Spin on Normal Force Longitudinal Distribution
(α = 10 Degrees)

Table 3. Effect of Angle of Attack on Normal Force and Moment Terms for $\hat{p} = 0$ (Rotating Band Off)

MODEL CONFIGURATION: 3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL
ROTATING BAND OFF
$Z_{cg/L} = .625$

TEST CONDITIONS: MACH .94
$pd/2v = 0$

TERM	$\alpha = 4^{o}$	$\alpha = 10^{o}$
C_{N_α}(OGIVE)	1.94	1.93
C_{N_α}(CYLINDER)	.25	.33
C_{N_α}(BOATTAIL)	-.64	-.36
C_{N_α}(TOTAL)	1.55	1.90
C_{m_α}(OGIVE)	3.45	3.46
C_{m_α}(CYLINDER)	-.50	-.35
C_{m_α}(BOATTAIL)	1.22	.70
C_{m_α}(TOTAL)	4.17	3.82
$Z_{cp/L}$	.15	.30

Table 4. Effect of Angle of Attack on Normal force and Moment Terms for $\hat{p} = -.162$ (Rotating Band Off)

MODEL CONFIGURATION: 3 CALIBER OGIVE, 2 CALIBER CYLINDER, .5 CALIBER BOATTAIL, ROTATING BAND OFF, $Z_{cg}/L = .625$

TEST CONDITIONS: MACH .94, $pd/2V = .162$

TERM	$\alpha = 4^{o}$	$\alpha = 10^{o}$
C_{N_α}(OGIVE)	1.96	1.94
C_{N_α}(CYLINDER)	.30	.60
C_{N_α}(BOATTAIL)	-.68	-.31
C_{N_α}(TOTAL)	1.59	2.24
C_{m_α}(OGIVE)	3.47	3.47
C_{m_α}(CYLINDER)	-.36	-.36
C_{m_α}(BOATTAIL)	1.30	.60
C_{m_α}(TOTAL)	4.41	3.71
Z_{cp}/L	.13	33

Table 5. Effect of Spin on Normal force and Moment Terms for $\alpha = 4$ degrees (Rotating Band Off)

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CAL BOATTAIL
REF c.g. AT Z/L = .625

TEST CONDITION: MACH .94
$\alpha = 4^o$
$R_d = 4x10^6$/FT

TERM	p = 0 ($\hat{\beta} = 0$)	p = -4900 RPM ($\hat{\beta} = -.162$)
C_{N_α} (OGIVE)	1.94	1.96
C_{N_α} (CYLINDER)	.25	.30
C_{N_α} (BOATTAIL)	-.64	-.68
C_{N_α} (TOTAL)	1.55	1.59
C_{m_α} (OGIVE)	3.45	3.47
C_{m_α} (CYLINDER)	-.50	-.36
C_{m_α} (BOATTAIL)	1.22	1.30
C_{m_α} (TOTAL)	4.17	4.41
Z_{cp}/L	.15	.13

Table 6. Effect of Spin on Normal Force and Moment Terms for α = 10 Degrees (Rotating Band Off)

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CAL BOATTAIL
REF c.g. AT Z/L = .625

TEST CONDITION: MACH .94
$\alpha = 10^{o}$
$R_d = 4x10^6$/FT

TERM	p = 0 ($\hat{p}$ = 0)	p = –4900 RPM ($\hat{p}$ = –.162)
C_{N_α} (OGIVE)	1.93	1.94
C_{N_α} (CYLINDER)	.33	.60
C_{N_α} (BOATTAIL)	–.36	–.31
C_{N_α} (TOTAL)	1.90	2.24
C_{m_α} (OGIVE)	3.46	3.47
C_{m_α} (CYLINDER)	–.35	–.36
C_{m_α} (BOATTAIL)	–.70	.60
C_{m_α} (TOTAL)	3.82	3.71
Z_{cp}/L	.27	.33

5.4 Rotating Band Effect.

Details of the rotating band configuration used with the model are contained in Appendix D. Figure 34 compares the longitudinal surface pressure distribution over the non-spinning model at zero angle of attack, both with and without the rotating band. The presence of the rotating band creates larger negative surface pressures in the area of the band and has the effect of moving the low pressure expansion region over the boattail slightly forward. The effect of spin on the pressure distribution over the spinning model with the rotating band at zero angle of attack is illustrated in Figure 35. Spin has the main effect of evening out the pressures on the lands and in the grooves of the rotating band which could be important to theoretical and numerical analyses. The influence of the rotating band on the side force distribution of the spinning model at an angle of attack of 10 degrees is presented in Figure 36. As can be seen, the presence of the rotating band results in significantly larger local Magnus forces in the band area compared to the no band case. On the boattail, the effect of the rotating band reduces the peak local Magnus force, as well as the area over which it acts, relative to the no rotating band condition. The relatively large effects of the band on the cylinder and boattail are essentially self-compensating and result in very little difference in the total Magnus force and moment coefficients between the rotating band on and off cases, as shown in Table 7.

The normal force distribution due to spin for the projectile with rotating band at a 10 degree angle of attack is shown in Figure 37. The effect of the rotating band on the normal force and moment terms is contained in Table 8. For the projectile having the rotating band, the influence of spin is to reduce the local normal force over both the cylinder and the boattail compared to the non-spinning case. The net result is that the spinning projectile possesses a greatly reduced normal force and a slightly lower pitching moment than when not spinning.

5.5 Base Pressure.

Data obtained from pressure tap 20, located on the rear facing surface of the projectile model base, are summarized in Figure 38. At an angle of attack of 0 degrees, the base pressure is very small, and, in fact, is positive for the spinning case. The pressure becomes more negative with increasing angle of attack. No definite trend is evident with spin and angle of attack.

5.6 Comparison of Surface Pressure Test Results With Other Data Sources.

The data from the surface pressure wind tunnel test can be compared with data from other experimental and theoretical sources in order to validate and assess the results. First, the non-spinning pressure distribution from this test can be directly compared with similar data obtained on a model configuration and size in the Langley 16-Foot Transonic Wind Tunnel.[7] Because of the non-spinning condition, only the normal force and moment terms are available and are shown for angles of attack of 4 and 10 degrees in Tables 9 and 10, respectively. Although both projectile models had identical ogive and cylindrical sections, the Langley test model included a 1-caliber boattail; whereas the Ames test model we used had a 0.5-caliber boattail. This difference is evident in the force and moment terms for the boattail and the subsequently larger coefficient derivative for the unstable pitching moment of the larger boattail.

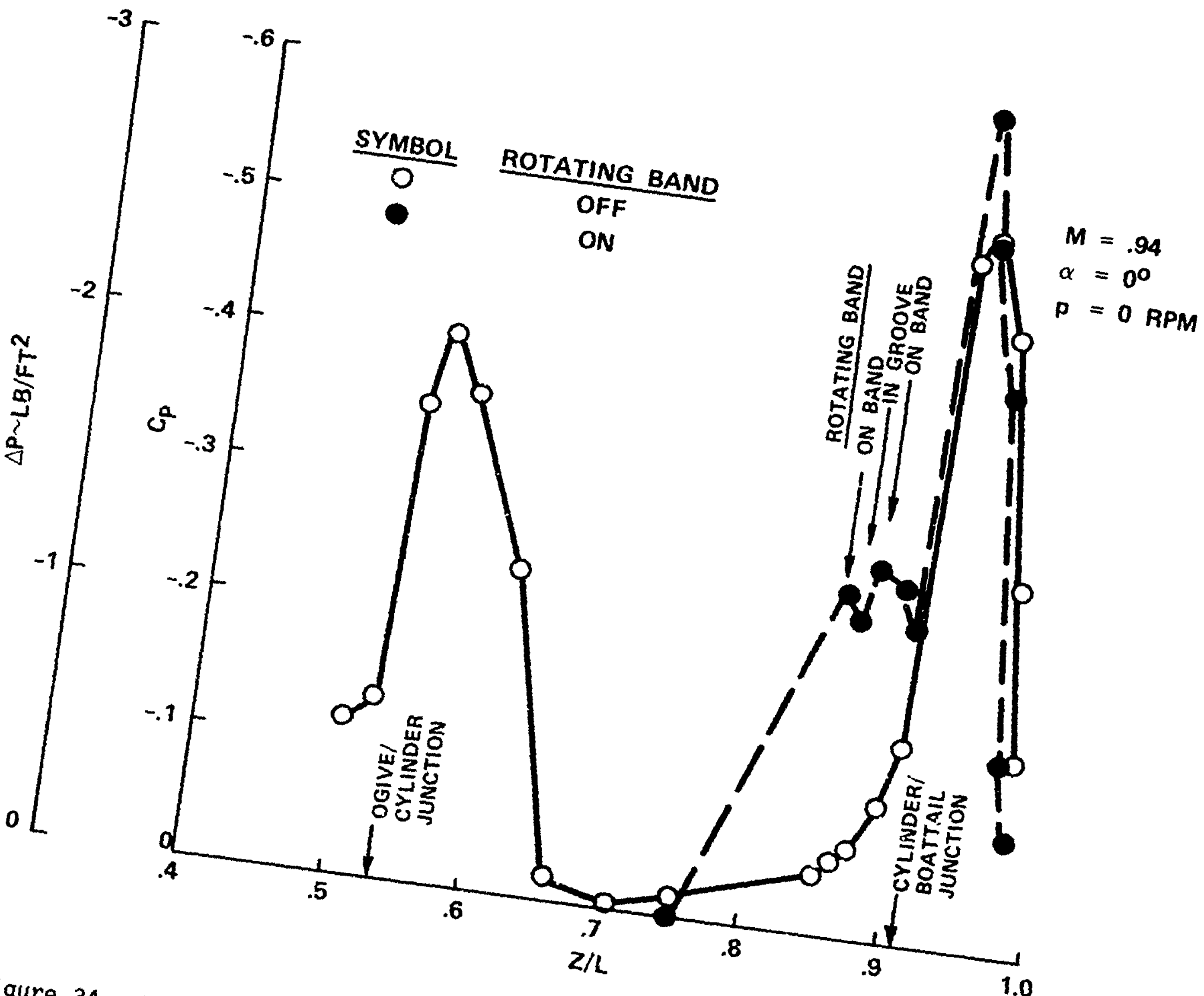


Figure 34. Effect of Rotating Band on Longitudinal Pressure Distribution
(α = 0 Degree)

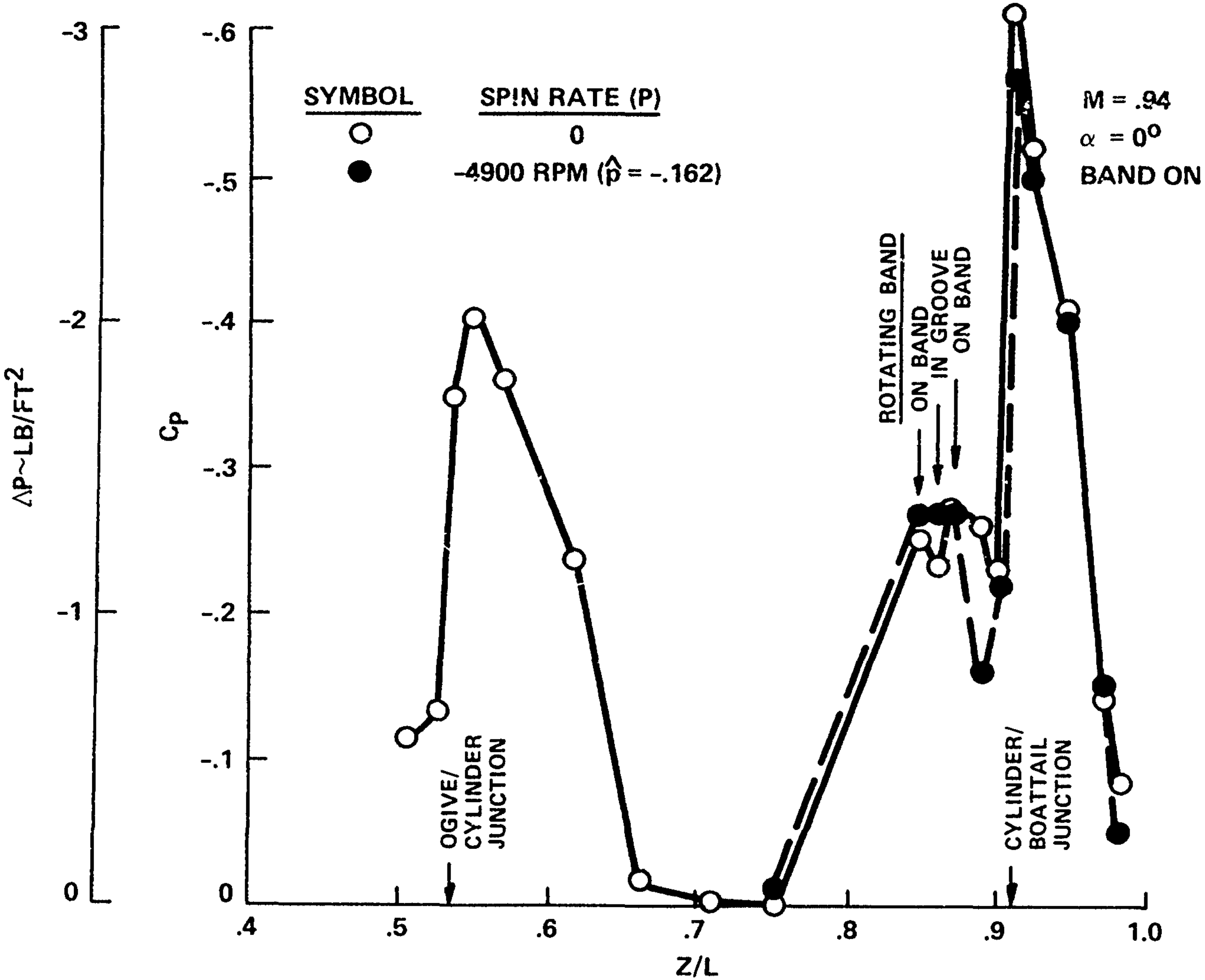


Figure 35. Effect of Spin on Longitudinal Pressure Distribution Over Model With rotating Band (α = 0 Degrees)

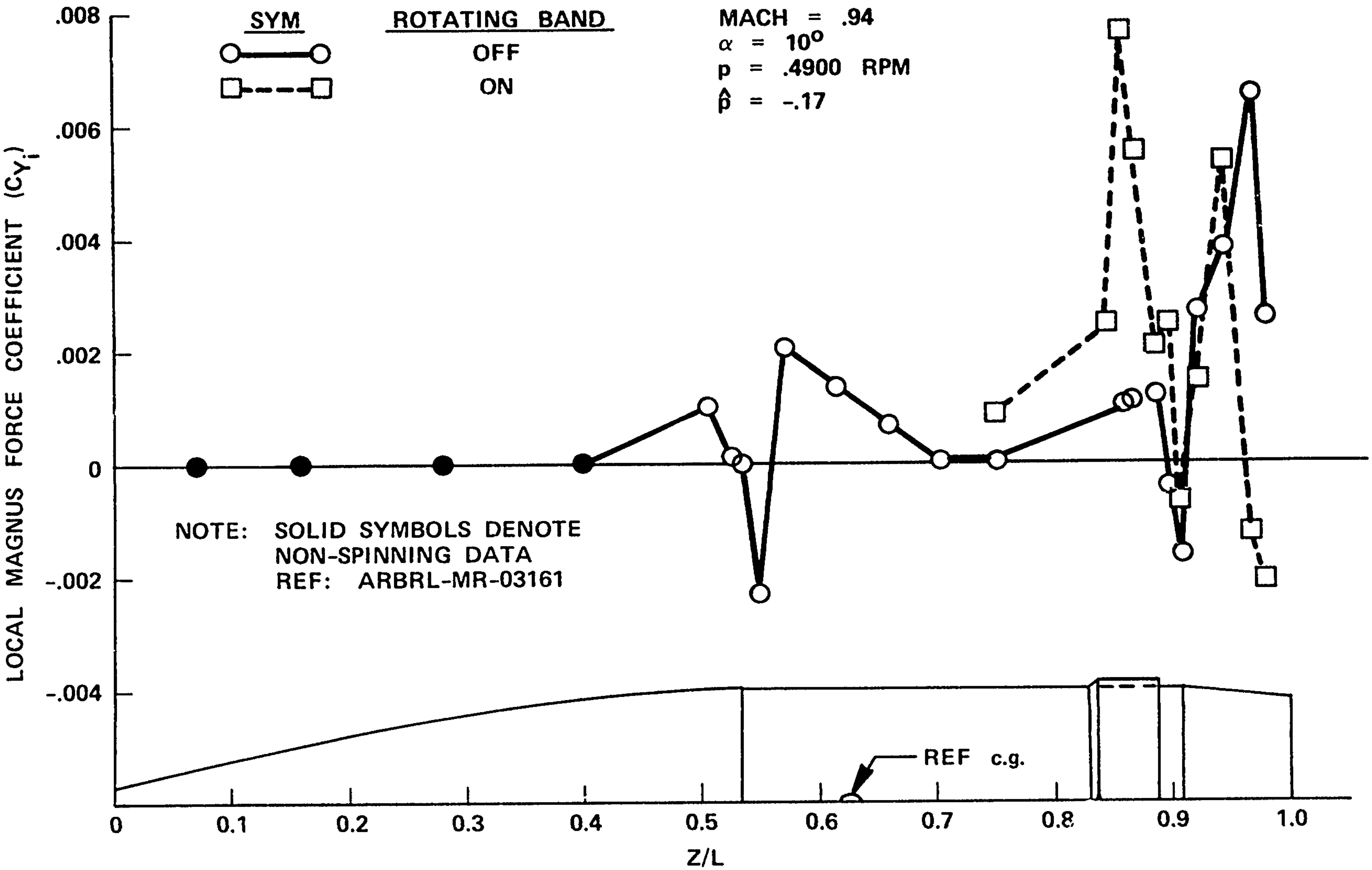


Figure 36. Magnus Side force Distribution on Spinning Model With and Witnout Rotating Band (α = 10 Degrees)

Table 7. Effect of Rotating Band on Side Force and Moment Terms
(α = 10 Degrees)

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL

TEST CONDITIONS: MACH .94
pd/2V = .162

TERM	ROTATING BAND OFF	ROTATING BAND ON
C_{Y_p} (OGIVE)	–.004	–.004
C_{Y_p} (CYLINDER)	–.092	–.149
C_{Y_p} (BOATTAIL)	–.080	–.026
C_{Y_p} (TOTAL)	–.176	–.179
C_{n_p} (OGIVE)	–.003	–.003
C_{n_p} (CYLINDER)	.063	–.139
C_{n_p} (BOATTAIL)	.148	.043
C_{n_p} (TOTAL)	.208	.180
Z_{cp}/L (MAGNUS)	.836	.804

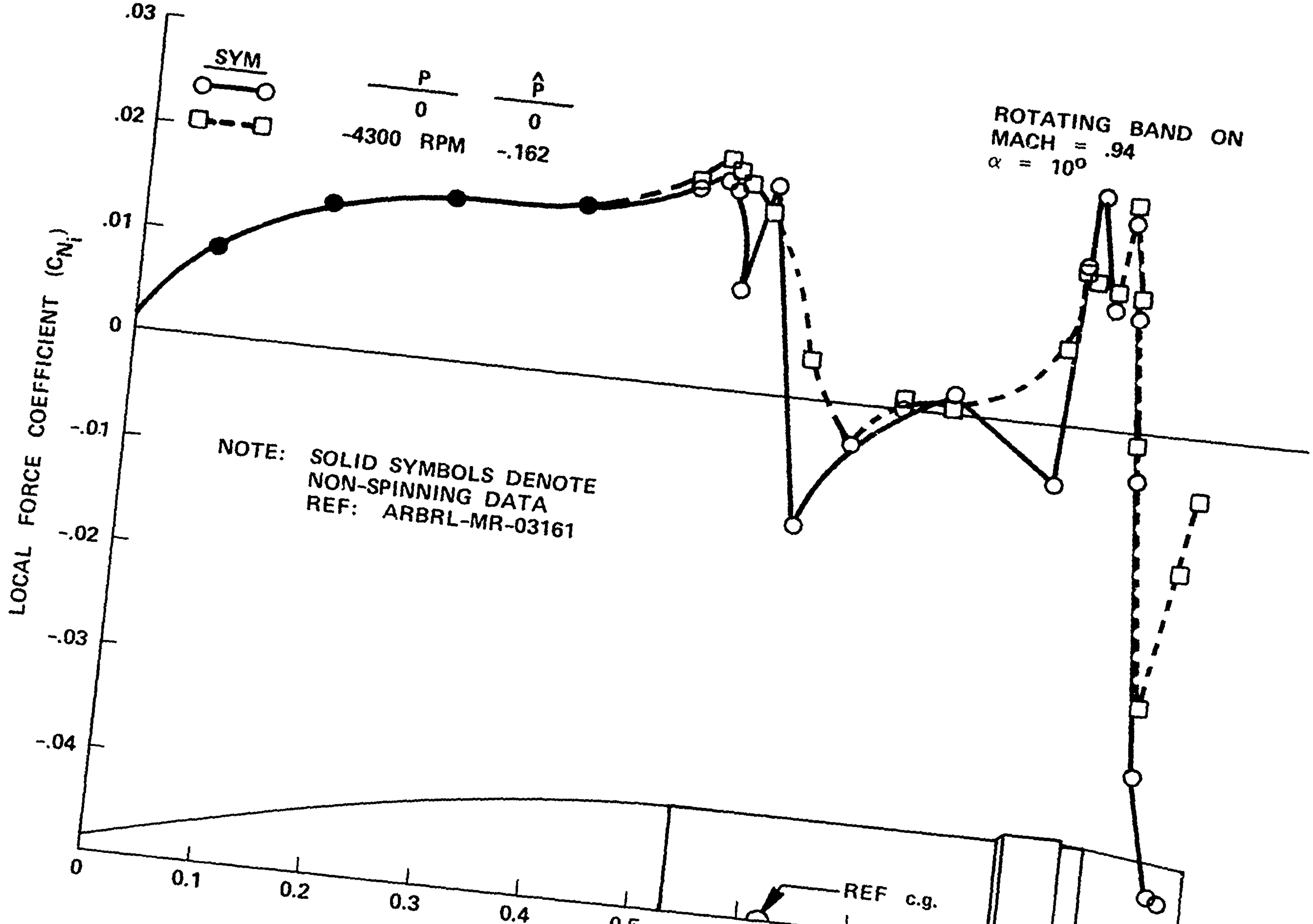


Figure 37. Effect of Spin on Normal Force Longitudinal Distribution Over Model With Rotating Band (α = 10 Degrees)

Table 8. Effect of Rotating Band on Normal Force and Moment Terms
(α = 10 Degrees)

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CAL BOATTAIL
REF c.g. AT Z/L = .625

TEST CONDITION: MACH .94
$\alpha = 10^o$
$R_d = 4x10^6/FT$
p = -4900 RPM
$\hat{p} = -.162$

TERM	ROTATING BAND OFF	ROTATING BAND ON
C_{N_α} (OGIVE)	1.94	1.95
C_{N_α} (CYLINDER)	.60	.62
C_{N_α} (BOATTAIL)	-.31	-.25
C_{N_α} (TOTAL)	2.24	2.32
C_{m_α} (OGIVE)	3.47	3.47
C_{m_α} (CYLINDER)	-.36	-.39
C_{m_α} (BOATTAIL)	.60	.46
C_{m_α} (TOTAL)	3.71	3.54
$Z_{cp/L}$	.33	.35

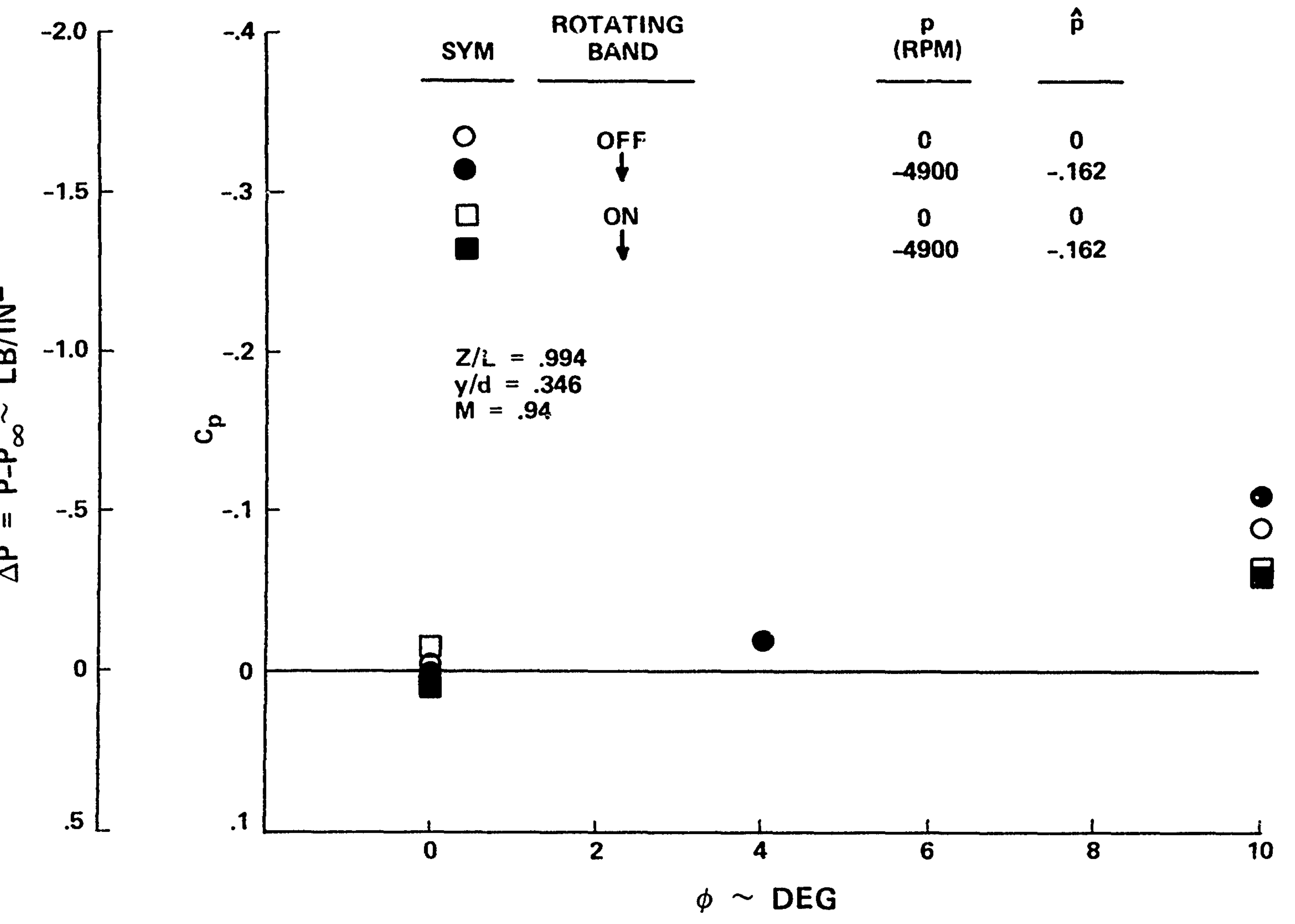


Figure 38. Effect of Angle of Attack and Spin on Model Base Pressure

Table 9. Comparison of Normal Force and Moment Data on Non-Spinning Model from Surface Pressure Test Data (α = 4 Degrees)

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
ROTATING BAND OFF
(SEE NOTE FOR BOATTAIL)
REF c.g. AT Z/L = .625

TEST CONDITION: MACH .94
$\alpha = 4^o$
$R_d = 4 \times 10^6$/FT
p = 0 RPM

TERM	PRESSURE MODEL NASA-AMES 14-FT TRANSONIC .5 CAL BOATTAIL	PRESSURE MODEL NASA-LANGLEY 16-FT TRANSONIC 1 CAL BOATTAIL
C_{N_α} (OGIVE)	1.94	2.05
C_{N_α} (CYLINDER)	.25	.17
C_{N_α} (BOATTAIL)	-.64	-.60
C_{N_α} (TOTAL)	1.55	1.62
C_{m_α} (OGIVE)	3.45	3.57
C_{m_α} (CYLINDER)	-.50	-.14
C_{m_α} (BOATTAIL)	1.22	1.07
C_{m_α} (TOTAL)	4.17	4.50
Z_{cp}/L	.145	.130

Table 10. Comparison of Normal Force and Moment Data on Non-Spinning Model from Surface Pressure Test Data (α = 10 Degrees)

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
(SEE NOTE FOR BOATTAIL)
ROTATING BAND OFF
REF c.g. AT Z/L = .625

TEST CONDITION: MACH .94
$\alpha = 10^o$
$R_d = 4 \times 10^6$/FT
p = 0 RPM

TERM	PRESSURE MODEL NASA-AMES 14-FT TRANSONIC .5 CAL BOATTAIL	PRESSURE MODEL NASA-LANGLEY 16-FT TRANSONIC 1 CAL BOATTAIL
C_{N_α}(OGIVE)	1.93	2.02
C_{N_α}(CYLINDER)	.33	.21
C_{N_α}(BOATTAIL)	-.36	-.67
C_{N_α}(TOTAL)	1.90	1.56
C_{m_α}(OGIVE)	3.46	3.55
C_{m_α}(CYLINDER)	-.35	-.20
C_{m_α}(BOATTAIL)	.70	1.14
C_{m_α}(TOTAL)	3.82	4.50
$Z_{cp/L}$	.27	.11

An internal balance was employed to directly measure the force and moment acting on a spinning projectile model.[2] Using this method, only the total force and moment coefficients could be determined. These directly measured terms are compared in Tables 11 and 12 with the same terms obtained by integrating the results of the surface pressure tests. The comparison is excellent, especially for the 10 degree angle-of-attack case where the model configurations both include rotating bands and are most similar.

One of the primary objectives of this test was to obtain experimental data that could be used to evaluate and evolve the Computational Fluid Dynamic (CFD) codes being developed to predict the flow field and resulting aerodynamic effects on spinning projectiles. A CFD code currently under development was used to calculate the aerodynamic terms for a projectile configuration and flight condition identical to that used in the wind tunnel test. The code is based on the solution to the thin-layer Navier-Stokes equations, as described by Nietubicz et al.,[8] and was run on a CRAY I computer. Table 13 compares the normal force term from the code with that from the surface pressure wind tunnel test and illustrates the excellent agreement achieved. The Magnus terms are compared in Table 14. In this case, the code under predicts the Magnus force by a significant amount.

6. CONCLUSIONS

- The sliding seal technique is capable of accurately measuring the Magnus-induced surface pressures on a spinning projectile wind tunnel model at transonic Mach numbers.
- Check runs showed excellent repeatability and demonstrated the absence of model or instrumentation asymmetries.
- Surface pressure data obtained in this test showed good agreement with the surface pressure data obtained on an identical, non-spinning model at the NASA-Langley 8-Foot Transonic Wind Tunnel.
- Total coefficients for Magnus force and moment computed by integrating the measured surface pressure data showed good agreement with directly measured force and moment data obtained from other spinning models.
- The data indicated the quantitative influence of spin and angle of attack and reveal that, for a given condition, different portions of the projectile can experience both positive and negative local Magnus forces.
- Quantitative pressure data were obtained to indicate the relative contribution of the various projectile elements (i.e., ogive, cylinder, boattail, rotating band) to the Magnus effect.
- A significant negative pressure region was detected on the advancing side of the leeward location at all longitudinal stations for a 10-degree angle of attack. This phenomenon was not noted at a 4-degree angle of attack.
- Base pressures at the test Mach number were found to be near free-stream static values.

Table 11. Comparison of Side Force and Moment Data on Spinning From Surface Pressure and Direct Force Tests for α = 4 Degrees

MODEL CONFIGURATION: 3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL
ROTATING BAND ON
$Z_{cg/L}$ = .625

TEST CONDITIONS: MACH .94
$\alpha = 10^{o}$
pd/2V = .162

TERM	INTEGRATION OF SURFACE PRESSURE DATA	DIRECT FORCE AND MOMENT DATA, REF: BRLMR22B4
C_{Y_p} (OGIVE)	-.004	—
C_{Y_p} (CYLINDER)	-.149	—
C_{Y_p} (BOATTAIL)	-.026	—
C_{Y_p} (TOTAL)	-.179	-.175
C_{n_p} (OGIVE)	-.003	—
C_{n_p} (CYLINDER)	.139	—
C_{n_p} (BOATTAIL)	.043	—
C_{n_p} (TOTAL)	.180	.180
$Z_{cp/L}$ (MAGNUS)	.804	.808

Table 12. Comparison of Side Force and Moment Data on Spinning Model from Surface Pressure and Direct Force Tests for $\alpha = 10$ Degrees

MODEL CONFIGURATION:
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL
* ROTATING BAND OFF
** ROTATING BAND ON
$Z_{cg/L} = .625$

TEST CONDITIONS:
MACH .94
$\alpha = 10^{o}$
pd/2V = .162

TERM	*INTEGRATION OF SURFACE PRESSURE DATA	**DIRECT FORCE AND MOMENT DATA, REF: BRLMR22B4
C_{Y_p} (OGIVE)	.000	—
C_{Y_p} (CYLINDER)	-.085	—
C_{Y_p} (BOATTAIL)	-.019	—
C_{Y_p} (TOTAL)	-.104	-.090
C_{n_p} (OGIVE)	.000	—
C_{n_p} (CYLINDER)	.056	—
C_{n_p} (BOATTAIL)	.033	—
C_{n_p} (TOTAL)	.090	.085
$Z_{cp/L}$ (MAGNUS)	.779	.793

Table 13. Comparison of Normal Force and Moment Terms From Surface Pressure Test Data and Computational Fluid Dynamic Code

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL
ROTATING BAND OFF
REF c.g. AT Z/L = .625

TEST CONDITIONS: MACH .94
$\alpha = 4^o$
$R_d = 4 \times 10^6$/FT
$pd/2V = .162$

TERM	INTEGRATION OF SURFACE PRESSURE WIND TUNNEL TEST DATA	COMPUTATIONAL FLUID DYNAMIC CODE
C_{N_α} (OGIVE)	1.96	
C_{N_α} (CYLINDER)	.30	
C_{N_α} (BOATTAIL	-.68	
C_{N_α} (TOTAL)	1.59	1.58
C_{m_α} (OGIVE)	3.47	
C_{m_α} (CYLINDER)	-.36	
C_{m_α} (BOATTAIL)	1.30	
C_{m_α} (TOTAL)	4.41	
$Z_{cp/L}$	.13	

Table 14. Comparison of Side Force and Moment Terms from Surface Pressure Test Data and Computational Fluid Dynamic Code

MODEL CONFIGURATION: 8 INCH DIAMETER MODEL
3 CALIBER OGIVE
2 CALIBER CYLINDER
.5 CALIBER BOATTAIL
ROTATING BAND OFF
Z_{cg}/L = .625

TEST CONDITIONS: MACH .94
$\alpha = 4^{o}$
$R_d = 4 \times 10^6$/FT
$pd/2V = .162$

TERM	INTEGRATION OF SURFACE PRESSURE WIND TUNNEL TEST DATA	COMPUTATIONAL FLUID DYNAMIC CODE
C_{Y_p} (OGIVE)	.000	
C_{Y_p} (CYLINDER)	-.085	
C_{Y_p} (BOATTAIL)	-.019	
C_{Y_p} (TOTAL)	-.104	-.015
C_{n_p} (OGIVE)	.000	
C_{n_p} (CYLINDER)	.056	
C_{n_p} (BOATTAIL)	.033	
C_{n_p} (TOTAL)	.090	
Z_{cp}/L (MAGNUS)	.78	

- The presence of the rotating band influenced the Magnus effects both upstream and downstream of the band, but in a compensating manner resulting in very little difference in the total Magnus effect between the band-off and band-on cases.

- Model components and instrumentation functioned well; however, pressure settling times of about 60 seconds were experienced. Future tests should employ shorter lengths of pressure tubing to decrease the data acquisition time.

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GLOSSARY

C_N	normal force coefficient N/qS
C_{N_i}	local normal force coefficient, $\sum_{j=1}^{360/\Delta\phi} 2\, C_{p_j} \dfrac{d_i\ \Delta z_i\ \sin\Delta\phi\ \cos\phi_j}{\pi d^2}$
C_{N_α}	$\partial C_N/\partial\alpha$
C_m	pitching moment coefficient, PM/qsd
C_{m_α}	$\partial C_m/\partial\alpha$
C_n	yawing moment coefficient, YM/qsd
C_{n_p}	$\partial C_n/\partial\hat{p}$
C_p	pressure coefficient, $(P - P_\infty)/q$
C_Y	side force coefficient
C_{Y_i}	local side force coefficient, $\sum_{j=1}^{360/\Delta\phi} 2\, C_{p_j} \dfrac{d_i\ \Delta z_i\ \sin\Delta\phi\ \sin\phi_j}{\pi d^2}$
C_{Y_p}	$\partial C_Y/\partial\hat{p}$
d	model reference diameter (7.95 inches)
i	subscript denotes value at location Z_i
j	subscript denotes value at location ϕ_j
L	projectile length (44.616 inches)
M	Mach number
N	normal force

P	surface pressure
P_∞	free stream static pressure
PM	pitching moment
p	spin rate
$\hat{p}$	tip speed ratio, $pd/2V$
q	dynamic pressure, $\rho v^2/2$
R_d	Reynolds number, v/ν
S	reference area, $\pi d^2/4$
SF	side force
SIGMA N	angle between the projectile center line and the sun direction
T_∞	free stream temperature
t	time
V	total free stream velocity
x, y, z	body axes
YM	yawing moment
Z	distance along model measured from nose
Z_{cg}	longitudinal location of reference center of gravity from nose
Z_{cp}/L	normal force center-of-pressure location from nose, $.625 - .1782(C_{m_\alpha}/C_{N_\alpha})$
Z_{cp}/L (Magnus)	Magnus force center-of-pressure location from nose, $.625 + .1782(C_{n_p}/C_{Y_p})$
α	angle of attack
ΔP	$P - P_\infty$
$\Delta\phi$	increment between circumferential locations
ν	air kinematic viscosity
π	ratio of circle circumference to diameter

ρ	air density
ϕ_j	circumferential location
θ	angle of projectile surface to projectile centerline

APPENDIX A

TABULATED WIND TUNNEL TEST DATA

This appendix presents the measured pressure data in tabulated format Each set of data relates to a specific model configuration and test condition: rotating band on or rotating band off, angle of attack of 0, 4, or 10 degrees, and spinning or non-spinning. The resulting pressure coefficients are presented as a function of azimuthal location (ϕ) for each longitudinal tap location (Z/L).

Data for the ogive area obtained during the Langley non-spinning test are also included to provide the total pressure distribution. The appendix figures contain the following data:

Figure	Rotating band	Angle of attack (deg)	Spin rate (rpm)	Run no.
A1	OFF	0	0	7-11, 12-25
A2	OFF	0	4900	73-92
A3	OFF	4	0	30-49
A4	OFF	4	4900	98-112
A5	OFF	10	0	113-122, 127-135
A6	OFF	10	4900	50-69
A7	ON	0	0	144-154
A8	ON	0	4900	181-192
A9	ON	10	0	157-168
A10	ON	10	4900	169-180

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.114	0.027	-0.044	-0.106	-0.404
22.5	0.000	0.000	0.000	0.000	0.000
45.0	0.000	0.000	0.000	0.000	0.000
67.5	0.000	0.000	0.000	0.000	0.000
90.0	0.123	0.035	-0.037	-0.100	-0.406
112.5	0.000	0.000	0.000	0.000	0.000
135.0	0.000	0.000	0.000	0.000	0.000
157.5	0.000	0.000	0.000	0.000	0.000
180.0	0.122	0.033	-0.039	-0.101	-0.406
202.5	0.000	0.000	0.000	0.000	0.000
225.0	0.000	0.000	0.000	0.000	0.000
247.5	0.000	0.000	0.000	0.000	0.000
270.0	0.123	0.035	-0.037	-0.100	-0.406
292.5	0.000	0.000	0.000	0.000	0.000
315.0	0.000	0.000	0.000	0.000	0.000
337.5	0.000	0.000	0.000	0.000	0.000

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	OFF
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	0 DEG.
SPIN RATE (P):	0 REV/MIN
TIP SPEED RATIO (PD/2V):	0
X CG/L	0.625112067

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706	3.957

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
10.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
20.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
30.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
40.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
50.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
60.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
70.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
80.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
90.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
100.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
110.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
120.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
130.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
140.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
150.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
160.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
170.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
180.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
190.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
200.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
210.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
220.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
230.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
240.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
250.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
260.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
270.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
280.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
290.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
300.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
310.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
320.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
330.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
340.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
350.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006

TAP LOCATION (Z/L):	0.75	0.848	0.859	0.87	0.888	0.899	0.91	0.922
TAP LOCATION (Z/D):	4.209	4.757	4.82	4.883	4.983	5.046	5.109	5.176
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************	***************	***************	***************
0.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
10.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
20.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
30.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
40.0	[illegible]	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
50.0	[illegible]	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
60.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
70.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
80.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
90.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
100.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
110.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
120.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
130.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
140.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
150.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
160.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
170.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
180.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
190.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
200.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
210.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
220.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
230.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
240.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
250.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
260.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
270.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
280.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
290.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
300.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
310.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
320.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
330.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
340.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524
350.0	-0.017	-0.045	-0.057	-0.067	-0.100	-0.144	-0.507	-0.524

TAP LOCATION (Z/L):	0.945	0.969	0.98
TAP LOCATION (Z/D):	5.303	5.438	5.5
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************
0.0	-0.455	-0.270	-0.142
10.0	-0.455	-0.270	-0.142
20.0	-0.455	-0.270	-0.142
30.0	-0.455	-0.270	-0.142
40.0	-0.455	-0.270	-0.142
50.0	-0.455	-0.270	-0.142
60.0	-0.455	-0.270	-0.142
70.0	-0.455	-0.270	-0.142
80.0	-0.455	-0.270	-0.142
90.0	-0.455	-0.270	-0.142
100.0	-0.455	-0.270	-0.142
110.0	-0.455	-0.270	-0.142
120.0	-0.455	-0.270	-0.142
130.0	-0.455	-0.270	-0.142
140.0	-0.455	-0.270	-0.142
150.0	-0.455	-0.270	-0.142
160.0	-0.455	-0.270	-0.142
170.0	-0.455	-0.270	-0.142
180.0	-0.455	-0.270	-0.142
190.0	-0.455	-0.270	-0.142
200.0	-0.455	-0.270	-0.142
210.0	-0.455	-0.270	-0.142
220.0	-0.455	-0.270	-0.142
230.0	-0.455	-0.270	-0.142
240.0	-0.455	-0.270	-0.142
250.0	-0.455	-0.270	-0.142
260.0	-0.455	-0.270	-0.142
270.0	-0.455	-0.270	-0.142
280.0	-0.455	-0.270	-0.142
290.0	-0.455	-0.270	-0.142
300.0	-0.455	-0.270	-0.142
310.0	-0.455	-0.270	-0.142
320.0	-0.455	-0.270	-0.142
330.0	-0.455	-0.270	-0.142
340.0	-0.455	-0.270	-0.142
350.0	-0.455	-0.270	-0.142

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	0	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

Figure A-1. (Cont'd)

DATA SOURCE : . LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.114	0.027	-0.044	-0.106	-0.404
22.5	0.000	0.000	0.000	0.000	0.000
45.0	0.000	0.006	0.000	0.000	0.000
67.5	0.000	0.000	0.000	0.000	0.000
90.0	0.123	0.035	-0.037	-0.100	-0.406
112.5	0.000	0.000	0.000	0.000	0.000
135.0	0.000	0.000	0.000	0.000	0.000
157.5	0.000	0.000	0.000	0.000	0.000
180.0	0.122	0.033	-0.039	-0.101	-0.406
202.5	0.000	0.000	0.000	0.000	0.000
225.0	0.000	0.000	0.000	0.000	0.000
247.5	0.000	0.000	0.000	0.000	0.000
270.0	0.123	0.035	-0.037	-0.100	-0.406
292.5	0.000	0.000	0.000	0.000	0.000
315.0	0.000	0.000	0.000	0.000	0.000
337.5	0.000	0.000	0.000	0.000	0.000

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	OFF
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	0 DEG.
SPIN RATE (P):	4900 REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427
X CG/L	0.625112067

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.540	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706	3.957
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.274	-0.036	-0.034
10.0	-0.127	-0.140	-0.361	-0.420	-0.367	-0.273	-0.036	-0.032
20.0	-0.127	-0.140	-0.361	-0.420	-0.368	-0.272	-0.036	-0.031
30.0	-0.127	-0.140	-0.361	-0.420	-0.369	-0.271	-0.036	-0.030
40.0	-0.127	-0.140	-0.361	-0.420	-0.370	-0.269	-0.036	-0.030
50.0	-0.127	-0.140	-0.361	-0.420	-0.370	-0.268	-0.036	-0.029
60.0	-0.127	-0.140	-0.361	-0.419	-0.370	-0.267	-0.036	-0.027
70.0	-0.127	-0.140	-0.361	-0.418	-0.370	-0.266	-0.036	-0.026
80.0	-0.127	-0.140	-0.361	-0.417	-0.370	-0.265	-0.036	-0.025
90.0	-0.127	-0.140	-0.361	-0.416	-0.370	-0.264	-0.036	-0.025
100.0	-0.128	-0.140	-0.360	-0.415	-0.370	-0.263	-0.036	-0.026
110.0	-0.128	-0.140	-0.360	-0.414	-0.370	-0.262	-0.036	-0.027
120.0	-0.128	-0.140	-0.360	-0.413	-0.370	-0.261	-0.036	-0.027
130.0	-0.128	-0.140	-0.360	-0.413	-0.370	-0.260	-0.036	-0.027
140.0	-0.129	-0.140	-0.360	-0.414	-0.371	-0.259	-0.036	-0.027
150.0	-0.129	-0.140	-0.360	-0.415	-0.371	-0.258	-0.036	-0.027
160.0	-0.129	-0.140	-0.360	-0.416	-0.371	-0.257	-0.036	-0.027
170.0	-0.129	-0.14	-0.360	-0.417	-0.371	-0.256	-0.036	-0.028
180.0	-0.129	-0.140	-0.360	-0.418	-0.372	-0.255	-0.036	-0.028
190.9	-0.137	-0.140	-0.364	-0.419	-0.372	-0.283	-P.036	-0.028
200.0	-0.136	-0.140	-0.363	-0.420	-0.371	-0.283	-0.036	-9.029
210.0	-0.135	-0.140	-0.362	-0.420	-0.370	-0.282	-0.036	-6.030
220.0	-0.135	-0.140	-0.362	-0.420	-0.369	-0.282	-0.036	-0.030
230.0	-0.134	-0.140	-0.362	-0.420	-0.369	-0.281	-0.036	-0.030
240.0	-0.132	-0.140	-0.362	-0.420	-0.369	-0.281	-0.036	-0.031
250.0	-0.132	-P.140	-0.361	-0.420	-0.369	-0.280	-0.036	-0.031
260.0	-0.131	-0.140	-0.361	-0.420	-0.368	-0.280	-0.036	-0.032
270.0	-0.129	-0.140	-0.361	-0.420	-0.368	-0.279	-0.036	-0.033
280.0	-0.128	-0.140	-0.361	-0.420	-0.367	-0.279	-0.036	-0.033
290.0	-0.128	-0.140	-0.361	-0.420	-0.367	-0.278	-0.036	-0.034
300.0	-0.128	-0.140	-0.361	-0.420	-0.367	-0.278	-0.036	-0.034
310.0	-0.128	-0.140	-0.361	-0.420	-0.366	-0.276	-0.036	-0.034
320.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.276	-0.036	-0.034
330.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.275	-0.036	-0.034
340.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.275	-0.036	-0.034
350.0	-0.127	-0.149	-0.361	-0.420	-0.366	-0.274	-0.036	-0.034

Figure A-2. Rotating Band Off, $\alpha = 0°$, P = 4900 rpm

TAP LOCATION (Z/L):	0.75	0.848	0.859	0.87	0.8[illegible]	0.899	0.91	0.922
TAP LOCATION (Z/D):	4.289	4.757	4.82	4.983	4.[illegible]	5.046	5.109	5.176
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	9.030	-0.070	-0.070	-0.100	-0.120	-0.174	-0.489	-0.513
10.0	0.030	-0 070	-0.070	-0.100	-0.120	-0.173	-0.489	-0.513
20.0	-0.030	-0.070	-0.070	-0.100	-0.120	-0.172	-0.489	-0.512
30.0	-0.030	-0.070	-0.070	-0.100	-0.120	-0.171	-0.488	-0.512
40.0	-0.030	-0.070	-0.070	-0.100	-0.12	-0.170	-0.488	-0.511
50.0	-0.030	-0.070	-0.070	-0.099	-0.120	-0.170	-0.488	-0.511
60.0	-0.030	-0.070	-0.070	-0.099	-0.120	-0.170	-0.488	-0.510
70.0	-0.030	-0.070	-0.070	-0.099	-0.120	-0.170	-0.488	-0.510
80.0	-0.029	-0.070	-0.070	-0.099	-0.120	-0.170	-0.489	-0.510
90.0	-0.029	-0.070	-0.070	-0.098	-0.123	-0.170	-0.489	-0.510
100.0	-0.029	-0.070	-0.07)	-0.098	-0.120	-0.170	-0.490	-0.510
110.0	-0.029	-0.07	-0.070	-0.096	-0.120	-0.170	-0.490	-0.510
120.0	-0.028	-0.070	-0.070	-0.096	-0.120	-0.170	-0.491	-0.510
130.0	-0.028	-0.070	-0.070	-0.096	-0.120	-0.170	-0.491	-0.509
140.0	-0.027	-0.670	-0.070	-0.096	-0.120	-0.170	-0.491	-0.509
150.0	-0.0[illegible]	-0.070	-0.070	-0.095	-0.120	-0.170	-0.491	-0.508
160.0	-0.026	-0.070	-0.070	-0.095	-0.120	-0.170	-0.492	-0.508
170.0	-0.026	-0.070	-0.070	-0.095	-0.120	-0.169	-0.492	-0.507
180.0	-0.026	-0.070	-0.070	-0.095	-0.120	-0.169	-0.492	-0.507
190.0	-0.032	-0.070	-0.070	-0.097	-0.120	-0.179	-0.492	-0.508
200.0	-0.032	-0.970	-0.070	-0.098	-0.120	-0.179	-0.492	-0.509
210.0	-0.033	-0.070	-0.070	-0.099	-0.120	-0.178	-0.492	-0.510
220.0	-0.033	-0.070	-0.070	-0.099	-0.120	-0.178	-0.491	-0.510
230.0	-0.033	-0.070	-C.07	-0.100	-0.120	-0.176	-0.491	-0.510
240.0	-0.033	-0.070	-0.070	-0.100	-0.120	-0.176	-0.491	-0.510
250.0	-0.033	-0.070	-0.070	-0.101	-0.120	-0.175	-0.491	-0.510
260.0	-0 033	-0.070	-0.070	-0.101	-0.120	-0.175	-0.490	-0.510
270.0	-0.032	-0.070	-0.070	-0.100	-0.120	-0.175	-0.490	-0.5[illegible]
280.0	-0.032	-0.070	-0.070	-0.100	-0.120	-0.175	-0.490	-0.510
290.0	-0.032	-0.070	-0.070	-0.100	-0.120	-0.174	-0.490	-0.511
30[illegible]	-0.032	-0.070	-0.070	-0.100	-0.120	-0.174	-0.490	-0.511
[illegible]	-0.031	-0.070	-0.070	-0.100	-0.120	-0.174	-0.489	-0.511
[illegible]	-0.031	-0.070	-0.070	-0.100	-0.120	-0.174	-0.489	-0.512
[illegible]	-0.031	-0.070	-0.070	-0.100	-0.120	-0.174	-0.489	-0.512
3[illegible].0	-0.030	-0.070	-0.070	-0.100	-0.120	-0.174	-0.489	-0.512
350.0	-0.030	-0.070	-0.070	-0.100	-0.120	-0.174	-0.489	-0.513

TAP LOCATION (Z/L):	0.945	0.969	0.98
TAP LOCATION (Z/D):	5 303	5.438	5.5
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.459	-0.274	-0.166
10.0	-0.459	-0.274	-0.167
20.0	-0.459	-0.274	-0.168
30.0	-0.459	-0.274	-0.170
40.0	-0.459	-0.274	0.170
50.	-0.459	-0.274	-0.171
60.0	-0.459	-0.274	-0.172
70.0	-0.459	-0.274	-0.172
80.0	-0.459	-0.274	-0.172
90.0	-0.459	-0.274	-0.173
100.0	-0.459	-0.274	-0.173
110.0	-0.459	-0.274	-0.172
120.0	-0.459	-0.274	-0.172
130.0	-0.459	-0.274	-0.171
140 0	-0.459	-0.273	-0.170
150.0	-0.459	-0.273	0.170
160.0	-0.459	-0.272	-0.170
170.0	-0.459	-0.272	-0.169
180.0	-0.459	-0.271	-0.169
190.0	-0.459	-0.271	-0.168
200.0	-0.459	-0.271	-0.167
210.0	-0.459	-0.271	-0.165
220.0	-0.459	-0.271	-0.164
230.0	-0.459	-0.272	-0.163
240.0	-0.459	-0.2[illegible]	-0.162
250.0	-0.459	-0 27[illegible]	-0.161
260.0	-0.459	-0.273	-0.160
270.0	-0.459	-0.273	-0.161
280.0	-0.459	-0.273	-0.161
290.0	-0.459	-0.273	-0.162
300.0	-0.459	-0.273	-0.163
310.0	-0.459	-0.274	-0.163
320.0	-0.459	-0.274	-0.164
330.0	-0.459	-0.274	-0.164
340.0	-0.459	-0.274	-0.165
350.0	-0.459	-0.274	-0.166

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	0	DEG.
SPIN RATE (P):	4900	REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427	
X CG/L	0.625112067	

Figure A-2. (Cont'd)

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.171	0.079	0.001	-0.068	-0.379
22.5	0.168	0.075	-0.002	-0.072	-0.382
45.0	0.152	0.060	-0.016	-0.084	-0.392
67.5	[illegible]	0.042	-0.033	-0.098	-0.402
90.0	0.110	0.021	-0.051	-0.113	-0.420
112.5	0.092	0.006	-0.064	-0.124	-0.424
135.0	0.079	-0.004	-0.071	-0.130	-0.423
157.5	0.077	-0.009	-0.074	-0.132	-0.419
180.0	0.071	-0.010	-0.074	-0.132	-0.415
202.5	0.073	-0.009	-0.074	-0.132	-0.419
225.0	0.079	-0.004	-0.071	-0.130	-0.423
247.5	0.092	0.006	-0.064	-0.124	-0.424
270.0	[illegible]	0.021	-0.051	-0.113	-0.420
292.5	0.132	0.042	-0.033	-0.098	-0.402
315.0	0.152	0.060	-0.016	-0.084	-0.392
337.5	0.168	0.075	-0.002	-0.072	-0.382

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	4	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.079	-0.088	-0.300	-0.392	-0.340	-0.235	3.012
10.0	-0.084	-0.092	-0.305	-0.393	-0.340	-0.238	-0.014
20.0	-0.090	-0.099	-0.308	-0.396	-0.342	-0.240	-0.018
30.	-0.097	-0.102	-0.312	-0.399	-0.346	-0.242	-0.019
40.	-0.103	-0.108	-0.318	-0.404	-0.352	-0.245	-0.020
50.0	-0.110	-0.115	-0.324	-0.409	-0.358	-0.249	-0.021
60.0	-0.118	-0.121	-0.331	-0.413	-0.365	-0.251	-0.023
70.0	-0.125	-0.129	-0.338	-0.417	-0.372	-0.254	-0.025
80.0	-0.130	-0.135	-0.344	-0.421	-0.379	-0.255	-0.027
90.0	-0.135	-0.140	-0.349	-0.423	-0.383	-0.253	-0.027
100.0	-0.141	-0.144	-0.355	-0.425	-0.385	-0.242	-0.025
110.0	-0.142	-0.149	-0.361	-0.424	-0.384	-0.229	-0.023
120.0	-0.145	-0.153	-0.365	-0.423	-0.383	-0.216	-0.020
130.0	-0.145	-0.156	-0.368	-0.422	-0.382	-0.204	-0.018
140.0	-0.145	-0.160	-0.371	-0.421	-0.379	-0.193	-0.016
150.0	-0.145	-0.162	-0.372	-0.417	-0.375	-0.184	-0.014
160.0	-0.144	-0.164	-0.375	-0.412	-0.371	-0.179	-0.014
170.0	-0.144	-0.165	-0.376	-0.407	-0.376	-0.176	-0.013
180.0	-0.141	-0.164	-0.376	-0.399	-0.370	-0.180	-0.012
190.0	-0.146	-0.165	-0.375	-0.408	-0.371	-0.179	-0.011
200.0	-0.146	-0.164	-0.374	-0.413	-0.370	-0.181	-0.012
210.0	-0.146	-0.163	-0.373	-0.418	-0.375	-0.186	-0.013
220.0	-0.146	-0.160	[illegible]	-0.423	-0.379	-0.197	-0.014
230.0	-0.146	-0.157	[illegible]	-0.423	-0.382	-0.207	-0.017
240.0	-0.145	-0.155	[illegible]	-0.424	-0.383	-0.220	-0.020
250.0	-0.144	-0.150	-0.360	-0.425	-0.385	-0.232	-0.022
260.0	-0.141	-0.146	-0.355	-0.426	-0.385	-0.245	-0.024
270.0	-0.135	-0.141	-0.349	-0.423	-0.382	-0.253	-0.026
280.0	-0.131	-0.136	-0.342	[illegible]	-0.379	-0.255	-0.025
290.0	-0.125	-0.129	-0.336	[illegible]	-0.371	-0.254	-0.024
300.0	-0.118	-0.122	-0.330	[illegible]	-0.365	-0.252	-0.022
310.0	-0.110	-0.116	-0.323	[illegible]	-0.357	-0.249	-0.020
320.0	-0.103	-0.109	-0.318	-0.403	-0.351	-0.245	-0.019
330.0	-0.097	-0.103	-0.313	-0.399	-0.346	-0.242	-0.019
340.0	-0.091	-0.098	-0.309	[illegible]	-0.342	-0.240	-0.017
350.0	-0.085	-0.092	-0.305	[illegible]	-0.340	-0.238	-0.015

Figure A-3. Rotating Band Off, $\alpha = 4°$, P = 0 rpm

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
TAP LOCATION (Z/L):	0.710	0.75	0.848	0.859	0.87	0.888	0.899
TAP LOCATION (Z/D):	3.987	4.209	4.757	4.82	4.883	4.983	5.046
0.0	-0.001	-0.011	-0.032	-0.039	-0.049	-0.072	-0.101
10.0	-0.003	-0.014	-0.032	-0.042	-0.050	-0.076	-0.103
20.0	-0.003	-0.019	-0.034	-0.045	-0.051	-0.080	-0.104
30.0	-0.007	-0.022	-0.039	-0.049	-0.056	-0.082	-0.109
40.0	-0.009	-0.026	-0.044	-0.054	-0.058	-0.085	-0.114
50.0	-0.013	-0.028	-0.048	-0.058	-0.064	-0.091	-0.120
60.0	-0.017	-0.029	-0.052	-0.061	-0.067	-0.096	-0.128
70.0	-0.018	-0.030	-0.055	-0.066	-0.071	-0.101	-0.136
80.0	-0.020	-0.032	-0.057	-0.068	-0.075	-0.105	-0.143
90.0	-0.018	-0.032	-0.059	-0.068	-0.078	-0.110	-0.150
100.0	-0.017	-0.031	-0.062	-0.069	-0.082	-0.116	-0.156
110.0	-0.015	-0.030	-0.062	-0.070	-0.084	-0.118	-0.161
120.0	-0.014	-0.029	-0.060	-0.069	-0.084	-0.119	-0.166
130.0	-0.012	-0.026	-0.060	-0.069	-0.085	-0.122	-0.171
140.0	-0.009	-0.023	-0.058	-0.070	-0.084	-0.123	-0.175
150.0	-0.008	-0.021	-0.056	-0.070	-0.084	-0.126	-0.178
160.0	-0.006	[illegible]	-0.055	-0.070	-0.083	-0.131	-0.180
170.0	-0.004	-0.019	-0.054	-0.070	-0.082	-0.128	-0.179
180.0	-0.003	-0.018	-0.054	-0.070	-0.082	-0.128	-0.178
190.0	-0.005	-0.020	-0.055	-0.070	-0.083	-0.128	-0.180
200.0	-0.006	-0.021	-0.057	-0.070	-0.083	-0.126	-0.181
210.0	-0.008	-0.024	-0.057	-0.070	-0.084	-0.125	-0.178
220.0	-0.011	-0.026	-0.060	-0.069	-0.084	-0.124	-0.175
230.0	-0.013	-0.028	-0.061	-0.070	-0.085	-0.122	-0.170
240.0	-0.016	-0.029	-0.062	-0.069	-0.084	-0.120	-0.166
250.0	-0.017	-0.030	-0.063	-0.069	-0.084	-0.119	-0.162
260.0	-0.018	-0.032	-0.062	-0.070	-0.082	-0.116	-0.156
270.0	-0.019	-0.032	-0.059	-0.070	-0.079	-0.111	-0.149
280.0	-0.020	-0.032	-0.057	-0.067	-0.075	-0.106	-0.145
290.0	-0.017	-0.030	-0.055	-0.065	-0.071	-0.102	-0.136
300.0	-0.015	-0.029	-0.052	-0.061	-0.066	-0.097	-0.130
310.0	-0.012	-0.028	-0.049	-0.058	-0.063	-0.091	-0.121
320.0	-0.010	-0.025	-0.044	-0.054	-0.059	-0.085	-0.114
330.0	-0.006	-0.021	-0.038	-0.050	-0.056	-0.082	-0.110
340.0	-0.009	-0.019	-0.034	-0.045	-0.053	-0.079	-0.104
350.0	-0.002	-0.014	-0.032	-0.043	-0.050	-0.076	-0.101

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
TAP LOCATION (Z/L):	0.91	0.922	0.945	0.969	[illegible]
TAP LOCATION (Z/D):	5.109	5.176	5.303	5.436	[illegible]
0.0	-0.468	[illegible]	-0.455	[illegible]	[illegible]
10.0	-0.463	[illegible]	-0.458	-0.395	[illegible]
20.0	-0.464	-0.539	-0.459	-0.399	-0.307
30.0	-0.470	-0.542	-0.463	-0.398	-0.306
40.0	-0.478	-0.543	-0.468	-0.400	[illegible]
50.0	-0.484	-0.545	-0.470	-0.397	-0.294
60.0	-0.490	[illegible]	-0.473	-0.395	-0.279
70.0	-0.497	-0.550	-0.475	-0.388	[illegible]
80.0	-0.505	-0.551	-0.476	-0.373	-0.234
90.0	-0.510	-0.551	-0.474	-0.349	-0.206
100.0	-0.517	-0.548	-0.471	-0.319	-0.179
110.0	-0.526	-0.545	-0.465	-0.283	-0.156
120.0	-0.530	-0.538	-0.455	-0.259	[illegible]
130.0	-0.535	-0.528	-0.440	-0.241	[illegible]
140.0	-0.542	-0.519	-0.430	-0.227	[illegible]
150.0	-0.547	-0.514	-0.420	-0.214	[illegible]
160.0	-0.550	-0.508	-0.415	-0.208	-0.120
170.0	-0.551	-0.502	-0.411	-0.204	-0.120
180.0	-0.551	-0.500	-0.411	-0.202	-0.119
190.0	-0.551	-0.504	-0.414	-0.204	-0.120
200.0	-0.549	-0.509	-0.416	-0.209	-0.121
210.0	-0.546	-0.516	-0.422	-0.217	-0.124
220.0	-0.542	-0.521	-0.431	-0.229	-0.129
230.0	-0.536	-0.531	-0.446	-0.243	-0.135
240.0	-0.531	-0.540	-0.458	-0.263	-0.145
250.0	-0.525	-0.545	-0.467	-0.289	-0.158
260.0	-0.517	-0.549	-0.471	-0.321	-0.181
270.0	-0.510	-0.551	-0.476	-0.353	-0.210
280.0	-0.506	-0.552	-0.475	-0.375	-0.236
290.0	-0.496	-0.550	-0.475	-0.389	-0.262
300.0	-0.490	-0.547	-0.473	-0.394	-0.289
310.0	-0.483	-0.546	-0.472	-0.399	-0.296
320.0	-0.479	-0.544	-0.468	-0.400	-0.303
330.0	-0.470	-0.541	-0.464	-0.399	-0.305
340.0	-0.464	-0.540	-0.460	-0.398	-0.308
350.0	-0.461	-0.535	-0.457	-0.395	-0.307

REF. LENGTH (L):	44.216	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	4	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
% CG/L	0.62511.067	

Figure A-3. (Cont'd)

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************
0.0	0.171	0.079	0.001	-0.068	-0.379
22.5	0.168	0.075	-0.002	-0.072	-0.382
45.0	0.152	0.060	-0.016	-0.084	-0.392
67.5	0.132	0.042	-0.033	-0.098	-0.402
90.0	0.110	0.021	-0.051	-0.113	-0.420
112.5	0.092	0.006	-0.064	-0.124	-0.424
135.0	0.079	-0.004	-0.071	-0.130	-0.423
157.5	0.073	-0.009	-0.074	-0.132	-0.419
180.0	0.071	-0.010	-0.074	-0.132	-0.415
202.5	0.073	-0.009	-0.074	-0.132	-0.419
225.0	0.079	-0.004	-0.071	-0.130	-0.423
247.5	0.092	0.006	-0.064	-0.124	-0.424
270.0	0.110	0.021	-0.051	-0.113	-0.420
292.5	0.132	0.042	-0.033	-0.098	-0.402
315.0	0.152	0.060	-0.016	-0.084	-0.392
337.5	0.168	0.075	-0.002	-0.072	-0.382

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	4	DEG.
SPIN RATE (P):	4900	REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427	
X CG/L	0.625112067	

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0 533	0.526	0.537	0.548	0.571	0.615	0.66
TAP LOCATION (Z/D):	2 [illegible]24	2.95	3.014	3.077	3.203	3.454	3.706
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************	***************	***************
0.0	-0.104	-0.098	-0.306	-0.389	-0.336	-0.246	-0.047
10.0	-0.107	-0.100	-0.307	-0.389	-0.336	-0.247	-0.051
20.0	-0.110	-0.101	-0.310	-0.389	-0.334	-0.248	-0.047
30.0	-0.113	-0.104	-0.316	-0.392	-0.341	-0.249	-0.051
40.0	-0.124	-0.111	-0.320	-0.398	-0.346	-0.252	-0.051
50.0	-0.131	-0.118	-0.324	-0.402	-0.352	-0.264	-0.054
60.0	-0.142	-0.124	-0.334	-0.405	-0.357	-0.266	-0.053
70.0	-0.149	-0.135	-0.342	-0.412	-0.364	-0.275	-0.056
80.0	-0.156	-0.143	-0.350	-0.417	-0.371	-0.276	-0.052
90.0	-0.164	-0.150	-0.351	-0.421	-0.378	-0.274	-0.050
100.0	-0.168	-0.156	-0.364	-0.421	-0.381	-0.273	-0.049
110.0	-0.166	-0.162	-0.367	-0.425	-0.387	-0.264	-0.045
120.0	-0.163	-0.167	-0.372	-0.428	-0.384	-0.246	-0.042
130.0	-0.162	-0.172	-0.376	-0.427	-0.385	-0.248	-0.041
140.0	-0.162	-0.176	-0.379	-0.422	-0.384	-0.242	-0.037
150.0	-0.162	-0.178	-0.384	-0.424	-0.380	-0.233	-0.036
160.0	-0.163	-0.181	-0.385	-0.418	-0.377	-0.232	-0.035
170.0	-0.161	-0.183	-0.388	-0.414	-0.373	-0.235	-0.033
180.0	-0.161	-0.188	-0.393	-0.406	-0.370	-0.246	-0.029
190.0	-0.166	-0.188	-0.390	-0.413	-0.367	-0.219	-0.031
200.0	-0.168	-0.191	-0.387	-0.417	-0.371	-0.224	-0.034
210.0	-0.165	-0.183	-0.382	-0.427	-0.376	-0.238	-0.035
220.0	-0.165	-0.173	-0.378	-0.432	-0.378	-0.259	-0.034
230.0	-0.166	-0.167	-0.376	-0.432	-0.383	-0.269	-0.036
240.0	-0.164	-0.165	-0.371	-0.436	-0.386	-0.279	-0.040
250.0	-0.160	-0.161	-0.367	-0.437	-0.388	-0.280	-0.044
260.0	-0.156	-0.154	-0.364	-0.436	-0.387	-0.286	-0.044
270.0	-0.153	-0.149	-0.358	-0.431	-0.379	-0.284	-0.048
280.0	-0.146	-0.150	-0.352	-0.425	-0.378	-0.285	-0.054
290.0	-0.138	-0.140	-0.347	-0.421	-0.372	-0.278	-0.054
300.0	-0.133	-0.133	-0.336	-0.419	-0.361	-0.274	-0.052
310.0	-0.125	-0.127	-0.333	-0.408	-0.358	-0.267	-0.051
320.0	-0.114	-0.115	-0.328	-0.405	-0.354	-0.264	-0.053
330.0	-0.101	-0.109	-0.318	-0.366	-0.344	-0.258	-0.048
340.0	-0.104	-0.103	-0.315	-0.389	-0.340	-0.252	-0.055
350.0	-0.106	-0.096	-0.305	-0.390	-0.340	-0.246	-0.051

CIRCUMFERENTIAL ANGLE (PHI)	TAP LOCATION (Z/L): 0.705 TAP LOCATION (Z/D): 3.957 PRESSURE COEFFICIENT (CP)	0.75 4.209 PRESSURE COEFFICIENT (CP)	0.948 4.757 PRESSURE COEFFICIENT (CP)	0.859 4.82 PRESSURE COEFFICIENT (CP)	0.87 4.883 PRESSURE COEFFICIENT (CP)	0.888 4.983 PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.010	-0.032	-0.046	-0.059	-0.064	-0.082	-0.108
10.0	-0.012	-0.032	-0.049	-0.054	-0.063	-0.083	-0.109
20.0	-0.014	-0.031	-0.038	-0.054	-0.062	-0.084	-0.108
30.0	-0.017	-0.035	-0.033	-0.058	-0.066	-0.084	-0.113
40.0	-0.022	-0.034	-0.032	-0.062	-0.071	-0.090	-0.118
50.0	-0.024	-0.039	-0.027	-0.063	-0.075	-0.094	-0.128
60.0	-0.027	-0.040	-0.027	-0.069	-0.080	-0.102	-0.138
70.0	-0.029	-0.045	-0.022	-0.075	-0.087	-0.108	-0.146
80.0	-0.031	-0.046	-0.024	-0.077	-0.088	-0.114	-0.152
90.0	-0.031	-0.044	-0.024	-0.082	-0.088	-0.120	-0.161
100.0	-0.032	-0.044	-0.022	-0.082	-0.095	-0.125	-0.172
110.0	-0.029	-0.042	-0.036	-0.084	-0.097	-0.127	-0.178
120.0	-0.028	-0.039	-0.040	-0.082	-0.097	-0.131	-0.184
130.0	-0.026	-0.037	-0.033	-0.081	-0.098	-0.134	-0.190
140.0	-0.025	-0.034	-0.028	-0.079	-0.096	-0.138	-0.191
150.0	-0.022	-0.030	-0.029	-0.069	-0.094	-0.138	-0.192
160.0	-0.020	0.028	-0.049	-0.065	-0.093	-0.137	-0.190
170.0	-0.019	-0.027	-0.055	-0.060	-0.091	-0.135	-0.189
180.0	-0.024	-0.025	-0.049	-0.060	-0.091	-0.135	-0.192
190.0	-0.015	-0.034	-0.046	-0.055	-0.103	-0.135	-0.190
200.0	-0.016	-0.035	-0.048	-0.052	-0.101	-0.134	-0.187
210.0	-0.019	-0.039	-0.048	-0.067	-0.102	-0.139	-0.184
220.0	-0.020	-0.044	-0.053	-0.082	-0.101	-0.144	-0.178
230.0	-0.024	-0.045	-0.053	-0.086	-0.100	-0.141	-0.173
240.0	-0.029	-0.050	-0.053	-0.083	-0.101	-0.135	-0.170
250.0	-0.031	-0.051	-0.051	-0.083	-0.100	-0.132	-0.167
260.0	-0.032	-0.052	-0.050	-0.083	-0.102	-0.129	-0.162
270.0	-0.031	-0.054	-0.043	-0.083	-0.096	-0.124	-0.155
280.0	-0.027	-0.049	-0.053	0.086	-0.097	-0.123	-0.151
290.0	-0.027	-0.045	-0.054	-0.082	-0.091	-0.118	-0.142
300.0	-0.025	-0.046	-0.044	-0.079	-0.090	-0.111	-0.136
310.0	-0.021	-0.042	-0.038	-0.070	-0.082	-0.106	-0.128
320.0	-0.017	-0.041	-0.035	-0.065	-0.079	-0.097	-0.123
330.0	-0.015	-0.040	-0.032	-0.062	-0.072	-0.092	-0.115
340.0	-0.012	-0.034	-0.049	-0.057	-0.071	-0.088	-0.112
350.0	-0.013	-0.035	-0.050	-0.056	-0.065	-0.085	-0.108

CIRCUMFERENTIAL ANGLE (PHI)	TAP LOCATION (Z/L): 0.91 TAP LOCATION (Z/D): 5.109 PRESSURE COEFFICIENT (CP)	0.922 5.176 PRESSURE COEFFICIENT (CP)	0.945 5.303 PRESSURE COEFFICIENT (CP)	0.969 5.438 PRESSURE COEFFICIENT (CP)	0.98 5.5 PRESSURE COEFFICIENT (CP)
0.0	-0.440	-0.514	-0.455	-0.400	-0.323
10.0	-0.439	-0.513	-0.452	-0.398	-0.326
20.0	-0.435	-0.516	-0.455	-0.395	-0.323
30.0	-0.441	-0.517	-0.453	-0.398	-0.316
40.0	-0.445	-0.521	-0.454	-0.394	-0.304
50.0	-0.452	-0.527	-0.455	[illegible]	-0.280
60.0	-0.456	-0.525	-0.465	-0.379	-0.258
70.0	-0.473	-0.529	-0.466	-0.361	-0.231
80.0	-0.484	-0.529	-0.468	-0.334	-0.206
90.0	-0.494	-0.530	-0.469	-0.300	-0.178
100.0	-0.502	-0.529	-0.465	-0.272	-0.164
110.0	-0.512	-0.528	-0.455	-0.247	-0.150
120.0	-0.519	-0.520	-0.442	-0.226	-0.146
130.0	-0.525	-0.512	-0.430	-0.213	-0.130
140.0	-0.528	-0.505	-0.415	-0.200	-0.123
150.0	-0.529	-0.503	-0.406	-0.191	-0.115
160.0	-0.527	-0.499	-0.396	-0.180	-0.109
170.0	-0.526	-0.497	-0.394	-0.181	-0.110
180.0	-0.524	-0.494	-0.392	-0.178	-0.111
190.0	-0.524	-0.487	-0.395	-0.174	-0.106
200.0	-0.518	-0.498	-0.407	-0.178	-0.108
210.0	-0.512	-0.512	-0.419	-0.183	-0.107
220.0	-0.511	-0.519	-0.491	-0.192	-0.107
230.0	-0.504	0.525	-0.454	-0.210	-0.123
240.0	-0.501	-0.528	-0.464	-0.229	-0.133
250.0	-0.496	-0.533	-0.466	-0.265	-0.142
260.0	-0.490	-0.538	-0.477	-0.293	-0.155
270.0	-0.485	-0.535	-0.472	-0.325	-0.174
280.0	-0.475	-0.533	-0.472	-0.349	-0.200
290.0	-0.466	-0.532	-0.471	-0.373	-0.231
300.0	-0.461	-0.528	-0.474	-0.388	-0.256
310.0	-0.452	-0.528	-0.466	-0.394	-0.272
320.0	-0.449	-0.526	-0.464	-0.396	-0.295
330.0	-0.446	-0.520	-0.460	-0.398	-0.306
340.0	-0.439	-0.516	-0.457	-0.396	-0.318
350.0	-0.439	-0.513	-0.454	-0.400	-0.321

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	OFF
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	4 DEG.
SPIN RATE (P):	4900 REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427
X CG/L	0.625112067

Figure A-4. (Cont'd)

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.272	0.172	0.083	0.000	-0.322
22.5	0.249	0.149	0.061	-0.020	-0.339
45.0	0.185	0.087	0.002	-0.075	-0.383
67.5	0.103	0.008	-0.071	-0.142	-0.445
90.0	0.035	-0.056	-0.125	-0.187	-0.468
112.5	0.000	-0.084	-0.136	-0.199	-0.486
135.0	-0.003	-0.081	-0.130	-0.184	-0.471
157.5	0.006	-0.072	-0.118	-0.164	-0.446
180.0	0.013	-0.059	-0.098	-0.152	-0.447
202.5	0.006	-0.072	-0.118	-0.164	-0.446
225.0	-0.003	-0.081	-0.130	-0.184	-0.471
247.5	0.000	-0.084	-0.136	-0.199	-0.486
270.0	0.035	-0.056	-0.125	-0.187	-0.468
292.5	0.103	0.008	-0.071	-0.142	-0.445
315.0	0.185	0.087	0.002	-0.075	-0.383
337.5	0.249	0.149	0.061	-0.020	-0.339

REF. LENGTH (L):	4-.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	10	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706	3.957
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.010	-0.030	-0.250	-0.351	-0.260	-0.166	-0.024	-0.012
10.0	-0.018	-0.041	-0.255	-0.357	-0.270	-0.174	-0.030	-0.009
20.0	-0.030	-0.060	-0.270	-0.368	-0.285	-0.186	-0.040	-0.006
30.0	-0.054	-0.078	-0.287	-0.385	-0.303	-0.203	-0.052	-0.014
40.0	-0.084	-0.101	-0.314	-0.406	-0.330	-0.229	-0.068	-0.029
50.0	-0.117	-0.131	-0.341	-0.430	-0.360	-0.259	-0.081	-0.049
60.0	-0.146	-0.161	-0.364	-0.451	-0.387	-0.289	-0.091	-0.068
70.0	-0.170	-0.190	-0.389	-0.475	-0.412	-0.312	-0.099	-0.086
80.0	-0.195	-0.210	-0.410	-0.489	-0.432	-0.329	-0.099	-0.096
90.0	-0.216	-0.230	-0.421	-0.500	-0.448	-0.338	-0.095	-0.097
100.0	-0.224	-0.234	-0.432	-0.503	-0.458	-0.321	-0.088	-0.092
110.0	-0.225	-0.238	-0.437	-0.502	-0.461	-0.277	-0.076	-0.079
120.0	-0.220	-0.232	-0.438	-0.498	-0.451	-0.216	-0.060	-0.060
130.0	-0.216	-0.227	-0.433	-0.486	-0.438	-0.168	-0.047	-0.045
140.0	-0.199	-0.219	-0.427	-0.468	-0.418	-0.140	-0.033	-0.030
150.0	-0.188	-0.213	-0.421	-0.449	-0.400	-0.120	-0.025	-0.020
160.0	-0.179	-0.209	-0.416	-0.434	-0.488	-0.108	-0.018	-0.012
170.0	-0.170	-0.208	-0.411	-0.430	-0.480	-0.096	-0.008	-0.005
180.0	-0.164	-0.207	-0.400	-0.429	-0.375	-0.091	-0.002	-0.003
190.0	-0.171	-0.206	-0.411	-0.430	-0.480	-0.096	-0.008	-0.005
200.0	-0.180	-0.209	-0.416	-0.434	-0.488	-0.108	-0.018	-0.012
210.0	-0.191	-0.213	-0.421	-0.449	-0.400	-0.120	-0.025	-0.020
220.0	-0.200	-0.219	-0.427	-0.468	-0.418	-0.140	-0.033	-0.030
230.0	-0.211	-0.227	-0.433	-0.486	-0.439	-0.168	-0.047	-0.045
240.0	-0.221	-0.232	-0.438	-0.498	-0.451	-0.216	-0.060	-0.060
250.0	-0.226	-0.238	-0.437	-0.502	-0.461	-0.277	-0.076	-0.079
260.0	-0.223	-0.234	-0.432	-0.503	-0.458	-0.321	-0.083	-0.092
270.0	-0.214	-0.230	-0.421	-0.500	-0.448	0.338	-0.095	-0.097
280.0	-0.195	-0.210	-0.410	-0.489	-0.432	-0.329	-0.099	-0.096
290.0	-0.170	-0.190	-0.389	-0.475	-0.412	-0.312	-0.099	-0.086
300.0	-0.146	-0.161	-0.364	-0.451	-0.387	-0.289	-0.091	-0.068
310.0	-0.117	-0.131	-0.341	-0.430	-0.360	-0.259	-0.081	-0.049
320.0	-0.083	-0.101	-0.314	-0.406	-0.330	-0.229	-0.068	-0.029
330.0	-0.054	-0.078	-0.287	-0.385	-0.303	-0.203	-0.052	-0.014
340.0	-0.030	-0.060	-0.270	-0.368	-0.285	-0.186	-0.040	-0.006
350.0	-0.019	-0.041	-0.255	-0.357	-0.270	-0.174	-0.030	[illegible]

Figure A-5. Rotating Band Off, $\alpha = 10°$, P = 0 rpm

TAP LOCATION (Z/L):	0.75	0.848	0.859	0.87	0.888	0.899	0.91	0.922
TAP LOCATION (Z/D):	4.209	4.757	4.82	4.883	4.983	5.046	5.109	5.176
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.010	0.000	-0.003	-0.004	-0.025	-0.043	-0.412	-0.521
10.0	-0.009	-0.003	-0.011	-0.010	-0.034	-0.050	-0.420	-0.527
20.0	-0.008	-0.011	-0.024	-0.021	-0.045	-0.065	-0.428	-0.536
30.0	-0.019	-0.030	-0.040	-0.041	-0.061	-0.085	-0.442	-0.550
40.0	-0.038	-0.052	-0.061	-0.064	-0.082	-0.104	-0.462	-0.565
50.0	-0.059	-0.074	-0.085	-0.090	-0.105	-0.141	-0.485	-0.581
60.0	-0.079	-0.095	-0.108	-0.112	-0.130	-0.154	-0.506	-0.600
70.0	-0.096	-0.115	-0.126	-0.131	-0.154	-0.179	-0.525	-0.613
80.0	-0.109	-0.124	-0.141	-0.143	-0.170	-0.195	-0.540	-0.621
90.0	-0.111	-0.130	-0.146	-0.152	-0.175	-0.208	-0.553	-0.624
100.0	-0.107	-0.130	-0.143	-0.151	-0.178	-0.215	-0.565	-0.625
110.0	-0.091	-0.120	-0.134	-0.144	-0.175	-0.220	-0.575	-0.614
120.0	-0.075	-0.103	-0.119	-0.133	-0.172	-0.223	-0.580	-0.587
130.0	-0.055	-0.095	-0.109	-0.125	-0.171	-0.230	-0.581	-0.541
140.0	-0.042	-0.089	-0.108	-0.122	-0.172	-0.225	-0.578	-0.506
150.0	-0.030	-0.083	-0.103	-0.119	-0.168	-0.225	-0.574	-0.496
160.0	-0.020	-0.076	-0.093	-0.106	-0.154	-0.204	-0.559	-0.512
170.0	-0.012	-0.063	-0.075	-0.090	-0.130	-0.173	-0.527	-0.572
180.0	-0.008	-0.048	-0.059	-0.074	-0.104	-0.150	-0.490	-0.598
190.0	-0.012	-0.063	-0.075	-0.090	-0.130	-0.173	-0.527	-0.572
200.0	-0.020	-0.076	-0.093	-0.106	-0.154	-0.204	-0.559	-0.512
210.0	-0.030	-0.083	-0.103	-0.119	-0.168	-0.225	-0.574	-0.496
220.0	-0.042	-0.089	-0.108	-0.122	-0.172	-0.235	-0.578	-0.506
230.0	-0.055	-0.095	-0.109	-0.125	-0.171	-0.230	-0.581	-0.541
240.0	-0.075	-0.103	-0.119	-0.133	-0.172	-0.223	-0.580	-0.587
250.0	-0.091	-0.120	-0.134	-0.144	-0.173	-0.220	-0.575	-0.614
260.0	-0.107	-0.130	-0.143	-0.151	-0.178	-0.215	-0.565	-0.625
270.0	-0.111	-0.130	-0.146	-0.152	-0.175	-0.208	-0.553	-0.624
280.0	-0.104	-0.124	-0.141	-0.143	-0.170	-0.195	-0.540	-0.621
290.0	-0.096	-0.115	-0.126	-0.131	-0.154	-0.179	-0.525	-0.613
300.0	-0.079	-0.095	-0.108	-0.112	-0.130	-0.154	-0.506	-0.600
310.0	-0.054	-0.074	-0.085	-0.090	-0.105	-0.141	-0.485	-0.581
320.0	-0.035	-0.052	-0.061	-0.064	-0.082	-0.104	-0.462	-0.565
330.0	-0.019	-0.030	-0.040	-0.041	-0.061	-0.085	-0.442	-0.550
340.0	-0.008	-0.011	-0.024	-0.021	-0.045	-0.065	-0.428	-0.536
350.0	-0.009	-0.003	-0.011	-0.010	-0.034	-0.050	-0.420	-0.527

TAP LOCATION (Z/L):	0.945	0.969	0.98
TAP LOCATION (Z/D):	5.303	5.438	5.5
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.426	-0.370	-0.358
10.0	-0.436	-0.377	-0.367
20.0	-0.447	-0.386	-0.380
30.0	-0.460	-0.400	-0.398
40.0	-0.479	-0.430	-0.414
50.0	-0.499	-0.441	-0.430
60.0	-0.513	-0.459	-0.446
70.0	-0.535	-0.474	-0.437
80.0	-0.550	-0.472	-0.389
90.0	-0.555	-0.437	-0.302
100.0	-0.546	-0.364	-0.220
110.0	-0.514	-0.276	-0.171
120.0	-0.459	-0.230	-0.149
130.0	-0.417	-0.205	-0.140
140.0	-0.397	-0.197	-0.134
150.0	-0.398	-0.182	-0.123
160.0	-0.402	-0.150	-0.110
170.0	-0.400	-0.125	-0.085
180.0	-0.395	-0.107	-0.073
190.0	-0.400	-0.125	-0.085
200.0	-0.402	-0.150	-0.110
210.0	-0.398	-0.182	-0.123
220.0	-0.397	-0.197	-0.134
230.0	-0.417	-0.205	-0.140
240.0	-0.459	-0.230	-0.149
250.0	-0.512	-0.276	-0.171
260.0	-0.546	-0.364	-0.220
270.0	-0.555	-0.437	-0.302
280.0	-0.550	-0.472	-0.389
290.0	-0.535	-0.474	-0.437
300.0	-0.518	-0.459	-0.446
310.0	-0.499	-0.441	-0.430
320.0	-0.479	-0.430	-0.414
330.0	0.460	-0.400	-0.398
340.0	-0.447	-0.396	-0.380
350.0	-0.436	-0.377	-0.367

REF. LENGTH (L):	44.216 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	OFF
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	.0 DEG.
SPIN RATE (P):	0 REV/MIN
TIP SPEED RATIO (PD/2V):	0
X CG/L	0.625[illegible]

Figure A-5. (Cont'd)

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.272	0.172	0.083	0.000	-0.322
22.5	0.249	0.149	0.061	-0.020	-0.339
45.0	0.185	0.087	0.002	-0.075	-0.383
67.5	0.103	0.008	-0.071	-0.142	-0.445
90.0	0.035	-0.056	-0.125	-0.187	-0.468
112.5	0.000	-0.084	-0.136	-0.199	-0.486
135.0	-0.003	-0.081	-0.130	-0.184	-0.471
157.5	0.006	-0.072	-0.118	-0.164	-0.446
180.0	0.013	-0.059	-0.093	-0.152	-0.447
202.5	0.006	-0.072	-0.118	-0.164	-0.446
225.0	-0.003	-0.081	-0.130	-0.184	-0.471
247.5	0.000	-0.084	-0.136	-0.199	-0.486
270.0	0.035	-0.056	-0.125	-0.187	-0.468
292.5	0.103	0.008	-0.071	-0.142	-0.445
315.0	0.185	0.087	0.002	-0.075	-0.383
337.5	0.249	0.149	0.061	0.020	-0.339

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	OFF
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	10 DEG.
SPIN RATE (P):	4900 REV/MIN
TIP SPEED RATIO (PD 2V):	0.16207427
X CG/L	0.625112067

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706	3.957

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.025	-0.039	-0.250	-0.340	-0.255	-0.166	-0.023	0.013
10.0	-0.027	-0.042	-0.255	-0.339	-0.256	-0.174	-0.024	0.011
20.0	-0.033	-0.055	-0.266	-0.350	-0.270	-0.186	-0.032	0.000
30.0	-0.055	-0.075	-0.282	-0.367	-0.291	-0.203	-0.052	-0.015
40.0	-0.097	-0.101	-0.3	-0.387	-0.318	-0.229	-0.068	-0.039
50.0	-0.117	-0.131	-0.33	-0.411	-0.345	-0.259	-0.081	-0.053
60.0	-0.155	-0.157	-0.356	-0.434	-0.377	-0.289	-0.096	-0.090
70.0	-0.179	-0.187	-0.38	-0.460	-0.407	-0.312	-0.106	-0.996
80.0	-0.204	-0.211	-0.410	-0.489	-0.428	-0.329	-0.109	-0.104
90.0	-0.226	-0.229	-0.419	-0.492	-0.449	-0.338	-0.105	0.105
100.0	-0.231	-0.241	-0.432	-0.504	-0.458	-0.321	-0.100	-0.038
110.0	-0.236	-0.246	-0.436	-0.502	-0.465	-0.277	-0.086	-0.083
120.0	-0.229	-0.244	-0.442	-0.500	-0.458	-0.216	-0.078	-0.065
130.0	-0.221	-0.241	-0.442	-0.589	-0.439	-0.168	-0.062	-0.053
140.0	-0.212	-0.241	-0.441	-0.569	-0.423	-0.140	-0.055	-0.048
150.0	-0.202	-0.241	-0.431	-0.551	-0.410	-0.120	-0.047	-0.041
160.0	-0.193	-0.231	-0.426	-0.540	-0.401	0.106	-0.029	-0.028
170.0	-0.187	-0.220	-0.417	-0.538	-0.389	-0.096	-0.008	-0.006
180.0	-0.185	-0.216	-0.419	-0.536	-0.381	-0.091	0.000	-0.006
190.0	-0.181	-0.226	-0.418	-0.436	-0.388	-0.096	-0.005	0.007
200.0	-0.190	-0.227	-0.419	-0.448	-0.397	-0.108	-0.011	-0.001
210.0	-0.200	-0.219	0.427	-0.453	-0.416	-0.120	-0.022	-0.012
220.0	-0.211	-0.222	-0.427	-0.479	-0.434	-0.140	-0.038	-0.030
230.0	-0.228	-0.232	-0.433	-0.490	-0.459	-0.168	-0.057	-0.051
240.0	-0.239	-0.240	-0.435	-0.500	-0.470	-0.216	-0.072	-0.076
250.0	-0.244	-0.243	-0.435	-0.506	-0.471	-0.277	-0.089	-0.098
260.0	-0.242	-0.241	-0.432	-0.507	-0.474	-0.321	-0.099	-0.109
270.0	-0.229	-0.234	-0.422	-0.507	-0.465	-0.338	-0.110	-0.113
280.0	-0.210	-0.223	-0.412	-0.489	-0.448	-0.329	-0.117	-0.114
290.0	-0.191	-0.196	-0.387	-0.468	-0.418	-0.312	-0.115	-0.101
300.0	-0.160	-0.167	-0.36	-0.451	-0.394	-0.289	-0.119	-0.087
310.0	-0.129	-0.139	[illegible]	-0.429	-0.364	-0.259	-0.105	-0.063
320.0	-0.099	-0.109	-0.307	-0.398	-0.333	-0.229	-0.088	-0.044
330.0	-0.072	-0.078	-0.283	-0.375	-0.301	-0.203	-0.061	-0.018
340.0	-0.048	-0.055	-0.262	-0.351	-0.277	-0.186	-0.045	-0.001
350.0	-0.030	-0.041	-0.251	-0.343	-0.265	-0.174	-0.030	0.012

CIRCUMFERENTIAL ANGLE (PHI)	TAP LOCATION (Z/L): 0.75 TAP LOCATION (Z/D): 4.209 PRESSURE COEFFICIENT (CP)	0.848 4.757 PRESSURE COEFFICIENT (CP)	0.859 4.82 PRESSURE COEFFICIENT (CP)	0.87 4.883 PRESSURE COEFFICIENT (CP)	0.888 4.983 PRESSURE COEFFICIENT (CP)	0.899 5.046 PRESSURE COEFFICIENT (CP)	0.91 5.109 PRESSURE COEFFICIENT (CP)	0.922 5.176 PRESSURE COEFFICIENT (CP)
0.0	-0.005	-0.009	-0.038	-0.011	-0.042	-0.059	-0.382	-0.509
10.0	-0.005	-0.010	-0.038	-0.013	-0.043	-0.064	-0.386	-0.504
20.0	-0.014	-0.019	-0.045	-0.026	-0.052	-0.071	-0.395	-0.508
30.0	-0.033	-0.036	-0.053	-0.045	-0.072	-0.093	-0.414	-0.518
40.0	-0.058	-0.059	-0.065	-0.069	-0.093	-0.112	-0.433	-0.535
50.0	-0.076	-0.061	-0.080	-0.094	-0.116	-0.149	-0.457	-0.556
60.0	-0.092	-0.103	-0.094	-0.121	-0.140	-0.169	-0.477	-0.574
70.0	-0.109	-0.121	-0.100	-0.145	-0.162	-0.187	-0.507	-0.588
80.0	-0.116	-0.134	-0.105	-0.156	-0.177	-0.210	-0.527	-0.607
90.0	-0.115	-0.137	-0.105	-0.162	-0.187	-0.225	-0.541	-0.615
100.0	-0.107	-0.130	-0.110	-0.159	-0.190	-0.238	-0.553	-0.618
110.0	-0.091	-0.120	-0.102	-0.150	-0.188	-0.246	-0.574	-0.598
120.0	-0.080	-0.111	-0.101	-0.149	-0.191	-0.260	-0.581	-0.541
130.0	-0.071	-0.110	-0.102	-0.149	-0.199	-0.263	-0.575	-0.506
140.0	-0.069	-0.121	-0.103	-0.167	-0.211	-0.275	-0.598	-0.501
150.0	-0.062	-0.119	-0.108	-0.159	-0.197	-0.250	-0.568	-0.506
160.0	-0.040	-0.087	-0.096	-0.120	-0.158	-0.210	-0.510	-0.624
170.0	-0.012	-0.065	-0.075	-0.093	-0.130	-0.177	-0.487	-0.600
180.0	-0.011	-0.064	-0.076	-0.091	-0.135	-0.188	-0.500	-0.550
190.0	-0.031	-0.070	-0.079	-0.108	-0.147	-0.222	-0.546	-0.479
200.0	-0.036	-0.076	-0.081	-0.115	-0.159	-0.239	-0.549	-0.469
210.0	-0.046	-0.086	-0.091	-0.120	-0.171	-0.239	-0.565	-0.484
220.0	-0.062	-0.099	-0.097	-0.123	-0.172	-0.229	-0.567	-0.537
230.0	-0.079	-0.115	-0.106	-0.140	-0.179	-0.228	-0.558	-0.595
240.0	-0.096	-0.134	-0.109	-0.158	-0.191	-0.230	-0.541	-0.615
250.0	-0.100	-0.149	-0.110	-0.171	-0.201	-0.234	-0.540	-0.622
260.0	-0.112	-0.160	-0.112	-0.185	-0.205	-0.234	-0.533	-0.623
270.0	-0.117	-0.162	-0.114	-0.181	-0.206	-0.231	-0.525	-0.621
280.0	-0.114	-0.156	-0.115	-0.175	-0.201	-0.22	-0.515	-0.619
290.0	-0.111	-0.141	-0.102	-0.167	-0.185	-0.201	-0.501	-0.609
300.0	-0.100	-0.123	-0.102	-0.131	-0.159	-0.181	-0.472	-0.594
310.0	-0.081	-0.100	-0.101	-0.106	-0.136	-0.153	-0.466	-0.572
320.0	-0.060	-0.072	-0.085	-0.077	-0.107	-0.121	-0.440	-0.556
330.0	-0.041	-0.044	-0.073	-0.050	-0.080	-0.100	-0.420	-0.540
340.0	-0.026	-0.024	-0.057	-0.027	-0.059	-0.078	-0.400	-0.521
350.0	-0.012	-0.011	-0.049	-0.018	-0.047	-0.065	-0.388	-0.511

CIRCUMFERENTIAL ANGLE (PHI)	TAP LOCATION (Z/L): 0.945 TAP LOCATION (Z/D): 5.303 PRESSURE COEFFICIENT (CP)	0.969 5.438 PRESSURE COEFFICIENT (CP)	0.98 5.5 PRESSURE COEFFICIENT (CP)
0.0	-0.421	-0.350	-0.359
10.0	-0.421	-0.350	-0.356
20.0	-0.424	-0.360	-0.369
30.0	-0.436	-0.368	-0.381
40.0	-0.464	-0.389	-0.400
50.0	-0.487	-0.410	-0.420
60.0	-0.505	-0.435	-0.431
70.0	-0.530	-0.452	-0.405
80.0	-0.546	-0.423	-0.310
90.0	-0.550	-0.341	-0.247
100.0	-0.524	-0.276	-0.201
110.0	-0.450	-0.241	-0.186
120.0	-0.419	-0.236	-0.177
130.0	-0.418	-0.229	-0.171
140.0	-0.446	-0.239	-0.176
150.0	-0.447	-0.224	-0.170
160.0	-0.403	-0.168	-0.176
170.0	-0.374	-0.133	-0.079
180.0	-0.373	-0.132	-0.080
190.0	-0.370	-0.149	-0.106
200.0	-0.367	-0.164	-0.120
210.0	-0.367	-0.175	-0.120
220.0	-0.386	-0.186	-0.123
230.0	-0.460	-0.201	-0.134
240.0	-0.538	-0.336	-0.151
250.0	-0.567	-0.236	-0.186
260.0	-0.570	-0.451	-0.255
270.0	-0.568	-0.499	-0.352
280.0	-0.557	-0.499	-0.413
290.0	-0.545	-0.481	-0.445
300.0	-0.521	-0.453	-0.445
310.0	-0.501	-0.430	-0.430
320.0	-0.479	-0.406	-0.409
330.0	-0.452	-0.383	-0.389
340.0	-0.433	-0.367	-0.372
350.0	-0.426	-0.356	-0.363

REF. LENGTH (L): 44.616 IN.
REF. DIAMETER (D): 7.9 IN.
ROTATING BAND: OFF
MACH NO.: 0.94
ANGLE OF ATTACK (ALPHA): 10 DEG.
SPIN RATE (P): 4900 REV/MIN
TIP SPEED RATIO (PD/2V): 0.162027437
X CG/L 0.625112067

Figure A-6. (Cont'd)

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.114	0.037	-0.044	-0.106	-0.404
22.5	0.000	0.000	0.000	0.000	0.000
45.0	0.000	0.000	0.000	0.000	0.000
67.5	0.000	0.000	0.000	0.000	0.000
90.0	0.121	0.035	-0.037	-0.100	-0.406
112.5	0.000	0.000	0.000	0.000	0.000
135.0	0.000	0.000	0.000	0.000	0.000
157.5	0.000	0.000	0.000	0.000	0.000
180.0	0.122	0.037	-0.039	-0.101	-0.406
202.5	0.000	0.000	0.000	0.000	0.000
225.0	0.000	0.000	0.000	0.000	0.000
247.5	0.000	0.000	0.000	0.000	0.000
270.0	0.123	0.035	-0.037	-0.100	-0.406
292.5	0.000	0.000	0.000	0.000	0.000
315.0	0.000	0.000	0.000	0.000	0.000
337.5	0.000	0.000	0.000	0.000	0.000

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	ON	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	0	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.924	2.95	3.014	3.077	3.203	3.454	3.706	3.957
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
10.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
20.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
30.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
40.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
50.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
60.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
70.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
80.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
90.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
100.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
110.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
120.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
130.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
140.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
150.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
160.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
170.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
180.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
190.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
200.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
210.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
220.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
230.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
240.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
250.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
260.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
270.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
280.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
290.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
300.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
310.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
320.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
330.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
340.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006
350.0	-0.116	-0.133	-0.352	-0.408	-0.363	-0.240	-0.019	-0.006

Figure A-7 Rotating Band On, $\alpha = 0°$, P = rpm

CIRCUMFERENTIAL ANGLE (PHI)	TAP LOCATION (Z/L): 0.75 TAP LOCATION (Z/D): 4.209 PRESSURE COEFFICIENT (CP)	0.848 4.757 PRESSURE COEFFICIENT (CP)	0.859 4.82 PRESSURE COEFFICIENT (CP)	0.87 4.883 PRESSURE COEFFICIENT (CP)	0.888 4.983 PRESSURE COEFFICIENT (CP)	0.899 5.046 PRESSURE COEFFICIENT (CP)	0.91 5.109 PRESSURE COEFFICIENT (CP)	0.922 5.176 PRESSURE COEFFICIENT (CP)
0.0	0.002	-0.252	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
10.0	0.002	-0.252	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
20.0	0.002	-0.253	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
30.0	0.002	-0.254	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
40.0	0.003	-0.254	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
50.0	0.003	-0.254	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
60.0	0.003	-0.254	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
70.0	0.003	-0.254	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523
80.0	0.003	-0.255	-0.231	-0.274	-0.261	-0.231	-0.613	-0.521
90.0	0.003	-0.256	-0.230	-0.274	-0.261	-0.231	-0.613	-0.521
100.0	0.003	-0.255	-0.230	-0.274	-0.261	-0.231	-0.613	-0.521
110.0	0.003	-0.254	-0.230	-0.274	-0.261	-0.231	-0.613	-0.521
120.0	0.003	-0.254	-0.230	-0.274	-0.261	-0.231	-0.613	-0.521
130.0	0.003	-0.253	-0.230	-0.275	-0.261	-0.231	-0.613	-0.521
140.0	0.003	-0.253	-0.230	-0.275	-0.261	-0.231	-0.613	-0.521
150.0	0.003	-0.252	-0.230	-0.275	-0.261	-0.231	-0.613	-0.521
160.0	0.003	-0.251	-0.230	-0.275	-0.261	-0.231	-0.613	-0.521
170.0	0.003	-0.251	-0.230	-0.275	-0.261	-0.231	-0.613	-0.521
180.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.231	-0.613	-0.521
190.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.231	-0.614	-0.521
200.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.231	-0.614	-0.521
210.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.232	-0.614	-0.521
220.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.232	-0.613	-0.521
230.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.232	-0.613	-0.521
240.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.232	-0.613	-0.522
250.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.232	-0.613	-0.522
260.0	0.003	-0.250	-0.230	-0.275	-0.261	-0.232	-0.613	-0.522
270.0	0.003	-0.249	-0.230	-0.274	-0.261	-0.232	-0.613	-0.522
280.0	0.003	-0.250	-0.230	-0.274	-0.261	-0.232	-0.613	-0.522
290.0	0.003	-0.251	-0.230	-0.274	-0.261	-0.232	-0.613	-0.522
300.0	0.003	-0.251	-0.230	-0.273	-0.261	-0.232	-0.613	-0.522
310.0	0.003	-0.251	-0.230	-0.273	-0.261	-0.232	-6.613	-0.522
320.0	0.002	-0.251	-0.230	-0.273	-0.261	-0.232	-0.613	-0.523
330.0	0.002	-0.251	-0.230	-0.273	-0.261	-0.231	-0.613	-0.523
340.0	0.002	-0.252	-0.230	-0.273	-0.261	-0.231	-0.613	-0.523
350.0	0.002	-0.252	-0.231	-0.273	-0.261	-0.231	-0.613	-0.523

CIRCUMFERENTIAL ANGLE (PHI)	TAP LOCATION (Z/L): 0.945 TAP LOCATION (Z/D): 5.303 PRESSURE COEFFICIENT (CP)	0.969 5.438 PRESSURE COEFFICIENT (CP)	0.98 5.5 PRESSURE COEFFICIENT (CP)
0.0	-0.412	-0.142	-0.090
10.0	-0.412	-0.142	-0.089
20.0	-0.413	-0.142	-0.088
30.0	-0.413	-0.142	-0.087
40.0	-0.414	-0.143	-0.086
50.0	-0.414	-0.143	-0.086
60.0	-0.414	-0.143	-0.084
70.0	-0.415	-0.143	-0.084
80.0	-0.416	-0.143	-0.083
90.0	-0.416	-0.143	-0.083
100.0	-0.415	-0.143	-0.083
110.0	-0.415	-0.143	-0.083
120.0	-0.414	-0.143	-0.084
130.0	-0.413	-0.142	-0.084
140.0	-0.412	-0.141	-0.085
150.0	-0.411	-0.140	-0.085
160.0	-0.410	-0.139	-0.085
176.0	-0.409	-0.138	-0.085
180.0	-0.409	-0.137	-0.085
190.0	-0.410	-0.136	-0.082
200.0	-0.410	-0.135	-0.082
210.0	-0.409	-0.133	-0.081
220.0	-0.409	-0.133	-0.081
230.0	-0.409	-0.134	-0.081
240.0	-0.409	-0.135	-0.080
250.0	-0.408	-0.137	-0.080
260.0	-0.408	-0.137	-0.079
270.0	-0.406	-0.138	-0.078
280.0	-0.407	-0.139	-0.079
290.0	-0.408	-0.139	-0.081
300.0	-0.409	-0.140	-0.083
310.0	-0.410	-0.140	-0.083
320.0	-0.410	-0.140	-0.084
330.0	-0.410	-0.140	-0.086
340.0	-0.411	-0.141	-0.088
350.0	-0.412	-0.141	-0.089

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	ON	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	0	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

Figure A-7. (Cont'd)

DATA SOURCE : . LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	2.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************
0.0	0.114	0.027	-0.044	-0.106	-0.404
22.5	0.000	0.000	0.000	0.000	0.000
45.0	0.000	0.000	0.000	0.000	0.000
67.5	0.000	0.000	0.000	0.000	0.000
90.0	0.123	0.035	-0.037	-0.100	-0.406
112.5	0.000	0.000	0.000	0.000	0.000
135.0	0.000	0.000	0.000	0.000	0.000
157.5	0.000	0.000	0.000	0.000	0.000
180.0	0.122	0.033	-0.039	-0.101	-0.406
202.5	0.002	0.100	0.000	0.000	0.000
225.0	0.000	0.000	0.000	0.000	0.000
247.5	0.002	0.000	0.000	0.000	0.000
270.0	0.122	0.035	-0.037	-0.100	-0.406
292.5	0.000	0.000	0.000	0.000	0.000
315.0	0.003	0.000	0.000	0.000	0.000
337.5	0.002	0.000	0.000	0.000	0.000

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	ON
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	0 DEG.
SPIN RATE (P):	4900 REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427
X CG/L	0.625112067

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706	3.957
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************	***************	***************	***************
0.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.274	-0.036	-0.034
10.0	-0.127	-0.140	-0.361	-0.420	-0.367	-0.273	-0.036	-0.032
20.0	-0.127	-0.140	-0.361	-0.420	-0.368	-0.272	-0.036	-0.031
30.0	-0.127	-0.140	-0.361	-0.420	-0.369	-0.271	-0.036	-0.030
40.0	-0.127	-0.140	-0.361	-0.420	-0.370	-0.269	-0.036	-0.030
50.0	-0.127	-0.140	-0.361	-0.420	-0.370	-0.268	-0.036	-0.029
60.0	-0.127	-0.140	-0.361	-0.419	-0.370	-0.267	-0.036	-0.027
70.0	-0.127	-0.140	-0.361	-0.418	-0.370	-0.266	-0.036	-0.026
80.0	-0.127	-0.140	-0.361	-0.417	-0.370	-0.265	-0.036	-0.025
90.0	-0.127	-0.140	-0.361	-0.416	-0.370	-0.264	-0.036	-0.025
100.0	-0.128	-0.140	-0.360	-0.415	-0.370	-0.263	-0.036	-0.026
110.0	-0.128	-0.140	-0.360	-0.414	-0.370	-0.262	-0.036	-0.027
120.0	-0.128	-0.140	-0.360	-0.413	-0.370	-0.261	-0.036	-0.027
130.0	-0.128	-0.140	-0.360	-0.413	-0.371	-0.260	-0.036	-0.027
140.0	-0.129	-0.140	-0.360	-0.414	-0.371	-0.259	-0.036	-0.027
150.0	-0.129	-0.140	-0.360	-0.415	-0.371	-0.258	-0.036	-0.027
160.0	-0.129	-0.140	-0.360	-0.416	-0.371	-0.257	-0.036	-0.027
170.0	-0.129	-0.14	-0.360	-0.417	-0.372	-0.256	-0.036	-0.028
180.0	-0.129	-0.140	-0.360	-0.418	-0.372	-0.255	-0.036	-0.028
190.0	-0.137	-0.140	-0.364	-0.419	-0.371	-0.283	-0.036	-0.028
200.0	-0.136	-0.140	-0.363	-0.420	-0.370	-0.283	-0.036	-0.029
210.0	-0.135	-0.140	-0.362	-0.420	-0.369	-0.282	-0.036	-0.030
220.0	-0.135	-0.140	-0.362	-0.420	-0.369	-0.282	-0.036	-0.030
230.0	-0.134	-0.140	-0.362	-0.420	-0.369	-0.281	-0.036	-0.031
240.0	-0.132	-0.140	-0.361	-0.420	-0.369	-0.281	-0.036	-0.031
250.0	-0.132	-0.140	-0.361	-0.420	-0.368	-0.280	-0.036	-0.032
260.0	-0.131	-0.140	-0.361	-0.420	-0.368	-0.280	-0.036	-0.033
270.0	-0.129	-0.140	-0.361	-0.420	-0.367	-0.279	-0.036	-0.033
280.0	-0.128	-0.140	-0.361	-0.420	-0.367	-0.279	-0.036	-0.034
290.0	-0.129	-0.140	-0.361	-0.420	-0.367	-0.278	-0.036	-0.034
300.0	-0.128	-0.140	-0.361	-0.420	-0.366	-0.278	-0.036	-0.034
310.0	-0.128	-0.140	-0.361	-0.420	-0.366	-0.276	-0.036	-0.034
320.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.276	-0.036	-0.034
330.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.275	-0.036	-0.034
340.0	-0.127	-0.140	-0.361	-0.420	-0.366	-0.275	-0.036	-0.034
350.0	-0.127	-0.140	-0.351	-0.420	-0.366	-0.274	-0.036	-0.034

Figure A-8. Rotating Band On, $\alpha = 0°$, P = 4900 rpm

TAP LOCATION (Z/L):	0.75	0.848	0.859	0.87	0.888	0.899	0.91	0.922
TAP LOCATION (Z/D):	4.209	4.757	4.82	4.883	4.983	5.046	5.109	5.176
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************	***************	***************	***************
0.0	-0.013	-0.267	-0.270	-0.202	-0.170	-0.226	-0.547	-0.503
10.0	-0.013	-0.266	-0.270	-0.210	-0.170	-0.223	-0.545	-0.501
20.0	-0.013	-0.265	-0.269	-0.218	-0.170	-0.221	-0.542	-0.499
30.0	-0.013	-0.265	-0.268	-0.221	-0.170	-0.220	-0.542	-0.498
40.0	-0.012	-0.264	-0.267	-0.229	-0.168	-0.219	-0.549	-0.494
50.0	-0.011	-0.264	-0.267	-0.233	-0.166	-0.218	-0.551	-0.492
60.0	-0.011	-0.263	-0.267	-0.235	-0.164	-0.216	-0.555	-0.490
70.0	-0.010	-0.262	-0.267	-0.238	-0.162	-0.212	-0.559	-0.487
80.0	-0.010	-0.262	-0.267	-0.240	-0.161	-0.210	-0.564	-0.485
90.0	-0.010	-0.262	-0.267	-0.243	-0.159	-0.210	-0.568	-0.481
100.0	-0.010	-0.263	-0.266	-0.244	-0.159	-0.213	-0.572	-0.482
110.0	-0.010	-0.264	-0.265	-0.249	-0.158	-0.216	-0.575	-0.484
120.0	-0.010	-0.266	-0.265	-0.251	-0.157	-0.218	-0.580	-0.486
130.0	-0.010	-0.267	-0.267	-0.252	-0.157	-0.221	-0.580	-0.488
140.0	-0.010	-0.267	-0.268	-0.258	-0.157	-0.224	-0.580	-0.489
150.0	-0.010	-0.268	-0.269	-0.259	-0.156	-0.227	-0.580	-0.490
160.0	-0.010	-0.268	-0.270	-0.262	-0.155	-0.230	-0.580	-0.491
170.0	-0.010	-0.268	-0.270	-0.266	-0.154	-0.234	-0.581	-0.493
180.0	-0.010	-0.269	-0.270	-0.268	-0.154	-0.236	-0.581	-0.495
190.0	-0.010	-0.269	-0.270	-0.077	-0.153	-0.219	-0.581	-0.496
200.0	-0.010	-0.269	-0.271	-0.087	-0.151	-0.219	-0.581	-0.495
210.0	-0.009	-0.270	-0.271	-0.084	-0.153	-0.219	-0.531	-0.495
220.0	-0.009	-0.270	-0.272	-0.091	-0.156	-0.219	-0.579	-0.495
230.0	-0.009	-0.270	-0.272	-0.098	-0.157	-0.219	-0.575	-0.495
240.0	-0.008	-0.270	-0.272	-0.101	-0.158	-0.219	-0.572	-0.495
250.0	-0.008	-0.270	-0.272	-0.108	-0.160	-0.219	-0.570	-0.495
260.0	-0.007	-0.270	-0.272	-0.112	-0.161	-0.219	-0.568	-0.495
270.0	-0.006	-0.271	-0.272	-0.119	-0.163	-0.219	-0.566	-0.495
280.0	-0.006	-0.270	-0.272	-0.130	-0.164	-0.220	-0.562	-0.496
290.0	-0.008	-0.269	-0.273	-0.140	-0.166	-0.220	-0.560	-0.498
300.0	-0.009	-0.269	-0.272	-0.151	-0.168	-0.221	-0.559	-0.499
310.0	-0.010	-0.268	-0.271	-0.157	-0.169	-0.221	-0.558	-0.500
320.0	-0.010	-0.268	-0.271	-0.168	-0.169	-0.222	-0.554	-0.501
330.0	-0.010	-0.268	-0.270	-0.179	-0.169	-0.222	-0.552	-0.502
340.0	-0.012	-0.267	-0.270	-0.187	-0.170	-0.222	-0.551	-0.503
350.0	-0.013	-0.267	-0.270	-0.195	-0.170	-0.223	-0.549	-0.503

TAP LOCATION (Z/L):	0.945	0.969	0.98
TAP LOCATION (Z/D):	5.303	5.438	5.5
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************
0.0	-0.402	-0.058	[illegible]64
10.0	-0.401	-0.059	[illegible]62
20.0	-0.399	-0.059	[illegible]60
30.0	-0.399	-0.060	-0.059
40.0	-0.398	-0.056	-0.058
50.0	-0.397	-0.054	-0.054
60.0	-0.394	-0.052	-0.052
70.0	-0.393	-0.050	-0.050
80.0	-0.392	-0.047	-0.058
90.0	-0.391	-0.045	-0.046
100.0	-0.392	-0.044	-0.045
110.0	-0.393	-0.043	-0.045
120.0	-0.394	-0.040	-0.044
130.0	-0.396	-0.038	-0.044
140.0	-0.397	-0.036	-0.043
150.0	-0.398	-0.034	-0.043
160.0	-0.399	-0.031	-0.042
170.0	-0.400	-0.029	-0.042
180.0	-0.400	-0.029	-0.041
190.0	-0.267	-0.029	-0.046
200.0	-0.281	-0.029	-0.047
210.0	-0.293	-0.029	-0.048
220.0	-0.309	-0.031	-0.049
230.0	-0.316	-0.035	-0.049
240.0	-0.328	-0.037	-0.050
250.0	-0.342	-0.039	-0.051
260.0	-0.353	-0.042	-0.052
270.0	-0.368	-0.046	-0.052
280.0	-0.371	-0.049	-0.053
290.0	-0.375	-0.050	-0.055
300.0	-0.379	-0.054	-0.057
310.0	-0.383	-0.054	-0.058
320.0	-0.387	-0.055	-0.059
330.0	-0.391	-0.056	-0.061
340.0	-0.394	-0.057	-0.062
350.0	-0.399	-0.058	-0.063

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	ON	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	0	DEG.
SPIN RATE (P):	4900	REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427	
X CG/L	0.625112067	

Figure A-8. (Cont'd)

DATA SOURCE : LANGLE,

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.84[illegible]	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.212	0.172	0.083	0.000	-0.322
22.5	0.244	0.144	0.061	-0.020	-0.339
45.0	0.185	0.087	0.002	-0.075	-0.383
67.5	0.105	0.003	-0.071	-0.142	-0.445
90.0	0.035	-0.056	-0.125	-0.167	-0.468
112.5	0.000	-0.084	-0.136	-0.199	-0.486
135.0	-0.002	-0.061	-0.130	-0.184	-0.471
157.5	0.006	-0.072	-0.118	-0.164	-0.446
180.0	0.013	-0.059	0.098	-0.152	-0.447
202.5	0.006	-0.072	-0.119	-0.164	-0.446
225.0	-0.001	-0.081	-0.130	-0.164	-0.471
247.5	0.000	0.084	-0.136	-0.194	-0.486
270.0	0.035	0.056	-0.125	-0.187	-0.468
292.5	0.101	0.008	0.071	-0.142	-0.445
315.0	0.155	0.037	0.002	-0.075	-0.383
337.5	0.243	0.144	0.061	-0.020	-0.339

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	ON	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	10	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

DATA SOURCE : AHEX

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.924	[illegible]	3.014	3.077	3.203	3.454	3.706	3.957
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.010	-0.030	-0.250	-0.351	-0.260	-0.166	-0.024	-0.012
10.0	-0.015	-0.041	-0.255	-0.357	-0.270	-0.174	-0.030	-0.009
20.0	-0.030	-0.060	-0.270	-0.368	-0.285	-0.186	-0.040	-0.006
30.0	0.054	-0.078	-0.287	-0.385	-0.303	-0.203	-0.052	-0.014
40.0	-0.084	-0.101	-0.314	-0.406	-0.330	-0.229	-0.068	-0.029
50.0	-0.117	-0.131	-0.341	-0.430	-0.360	-0.259	-0.081	-0.049
60.0	-0.146	0.161	-0.364	-0.451	-0.387	-0.289	-0.091	-0.068
70.0	-0.170	-0.190	-0.389	-0.475	-0.412	-0.312	-0.099	-0.086
80.0	-0.195	-0.210	-0.410	-0.489	-0.432	-0.329	-0.099	-0.096
90.0	-0.216	-0.230	-0.421	-0.500	-0.448	-0.338	-0.095	-0.097
100.0	-0.224	-0.234	-0.432	-0.503	-0.458	-0.321	-0.088	-0.092
110.0	0.225	-0.238	-0.437	-0.502	-0.461	-0.277	-0.076	-0.079
120.0	0.220	-0.232	-0.438	-0.498	-0.451	-0.216	-0.060	-0.060
130.0	-0.210	-0.227	-0.433	-0.486	-0.438	-0.168	-0.047	-0.045
140.0	-0.199	-0.219	-0.427	-0.466	-0.418	-0.140	-0.033	-0.030
150.0	-0.188	-0.213	-0.421	-0.449	-0.400	-0.120	-0.025	-0.020
160.0	-0.179	-0.209	-0.416	-0.434	-0.488	-0.108	-0.018	-0.012
170.0	-0.170	-0.208	-0.411	-0.430	-0.480	-0.096	-0.008	-0.005
180.0	-0.164	-0.207	-0.400	-0.429	-0.375	-0.091	-0.002	-0.003
190.0	-0.171	-0.208	-0.411	-0.430	-0.480	-0.096	-0.008	-0.005
200.0	-0.180	-0.209	-0.416	-0.434	-0.488	-0.108	-0.018	-0.012
210.0	-0.191	-0.213	-0.421	-0.449	-0.400	-0.120	-0.025	-0.020
220.0	-0.200	-0.219	-0.427	-0.468	-0.418	-0.140	-0.033	-0.030
230.0	-0.211	-0.227	-0.433	-0.486	-0.439	-0.168	-0.047	-0.045
240.0	-0.221	-0.232	-0.438	-0.498	-0.451	-0.216	-0.06	-0.060
250.0	-0.226	-0.238	-0.437	-0.502	-0.461	-0.277	-0.076	-0.079
260.0	-0.22[illegible]	-0.234	-0.432	-0.503	-0.458	-0.321	-0.088	-0.092
270.0	-0.214	-0.230	-0.421	-0.500	-0.449	-0.338	-0.095	-0.097
280.0	-0.195	-0.210	-0.410	-0.489	-0.432	-0.329	-0.099	-0.096
290.0	-0.170	-0.190	-0.389	-0.475	-0.412	-0.312	-0.099	-0.086
300.0	-0.146	-0.161	-0.364	-0.451	-0.387	-0.289	-0.091	-0.068
310.0	-0.117	-0.131	-0.341	-0.430	-0.360	-0.259	-0.081	-0.049
320.0	-0.083	-0.101	-0.314	-0.406	-0.330	-0.229	-0.068	-0.029
330.0	-0.054	-0.078	-0.287	-0.385	-0.303	-0.203	-0.052	-0.014
340.0	-0.030	-0.060	-0.270	-0.368	-0.285	-0.186	-0.040	-0.006
350.0	-0.019	-0.041	-0.255	-0.357	-0.270	-0.174	-0.030	-0.009

Figure A-9. Rotating Band On, $\alpha = 10°$, P = 0 rpm

TAP LOCATION (Z/L):	0.75	0.848	0.859	0.87	0.888	0.899	0.91	0.922
TAP LOCATION (Z/D):	4.289	4.757	4.82	4.883	4.983	5.046	5.109	5.176
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	0.031	-0.283	-0.146	-0.131	-0.181	-0.121	-0.528	-0.485
10.0	0.027	-0.293	-0.141	-0.136	-0.182	-0.120	-0.527	-0.488
20.0	0.019	-0.312	-0.148	-0.145	-0.190	-0.129	-0.544	-0.493
30.0	0.003	-0.339	-0.166	-0.167	-0.204	-0.147	-0.566	-0.509
40.0	-0.015	-0.352	-0.187	-0.192	-0.226	-0.120	-0.584	-0.529
50.0	-0.036	-0.396	-0.211	-0.220	-0.252	-0.199	-0.602	-0.553
60.0	-0.058	-0.407	-0.241	-0.250	-0.278	-0.221	-0.615	-0.573
70.0	-0.074	-0.426	-0.274	-0.279	-0.308	-0.247	-0.632	-0.594
80.0	-0.089	-0.435	-0.306	-0.305	-0.338	-0.278	-0.649	-0.600
90.0	-0.088	-0.445	-0.339	-0.331	-0.347	-0.285	-0.660	-0.605
100.0	-0.085	-0.438	-0.367	-0.346	-0.343	-0.286	-0.657	-0.598
110.0	-0.068	-0.433	-0.371	-0.341	-0.326	-0.283	-0.652	-0.582
120.0	-0.052	-0.421	-0.356	-0.336	-0.305	-0.274	-0.651	-0.558
130.0	-0.038	-0.341	-0.318	-0.339	-0.289	-0.281	-0.648	-0.478
140.0	-0.027	-0.283	-0.306	-0.340	-0.268	-0.304	-0.629	-0.433
150.0	-0.019	-0.261	-0.297	-0.334	-0.291	-0.307	-0.604	-0.432
160.0	-0.009	-0.253	-0.282	-0.320	-0.297	-0.308	-0.617	-0.444
170.0	0.003	-0.257	-0.266	-0.294	-0.305	-0.293	-0.640	-0.507
180.0	0.011	-0.264	-0.250	-0.263	-0.300	-0.251	-0.642	-0.500
190.0	-0.003	-0.250	-0.228	-0.298	-0.296	-0.263	-0.637	-0.510
200.0	-0.010	-0.244	-0.263	-0.323	-0.293	-0.282	-0.652	-0.463
210.0	-0.017	-0.253	-0.286	-0.331	-0.288	-0.296	-0.665	-0.443
220.0	-0.024	-0.273	-0.295	-0.334	-0.289	-0.310	-0.650	-0.432
230.0	-0.034	-0.335	-0.309	-0.343	-0.295	-0.308	-0.633	-0.472
240.0	-0.043	-0.392	-0.340	-0.353	-0.306	-0.303	-0.644	-0.523
250.0	-0.061	-0.429	-0.369	-0.364	-0.324	-0.306	-0.661	-0.558
260.0	-0.080	-0.435	-0.375	-0.362	-0.337	-0.313	-0.673	-0.580
270.0	-0.084	-0.423	-0.376	-0.358	-0.342	-0.309	-0.680	-0.590
280.0	-0.086	-0.406	-0.346	-0.336	-0.330	-0.302	-0.674	-0.595
290.0	-0.076	-0.392	-0.319	-0.314	-0.311	-0.278	-0.662	-0.588
300.0	-0.063	-0.369	-0.281	-0.273	-0.290	-0.258	-0.641	-0.574
310.0	-0.045	-0.346	-0.263	-0.234	-0.267	-0.219	-0.610	-0.550
320.0	-0.022	-0.336	-0.229	-0.199	-0.242	-0.185	-0.587	-0.525
330.0	-0.003	-0.312	-0.201	-0.168	-0.220	-0.161	-0.569	-0.509
340.0	0.016	-0.299	-0.171	-0.147	-0.202	-0.147	-0.550	-0.497
350.0	0.024	-0.289	-0.153	-0.136	-0.186	-0.129	-0.536	-0.489

TAP LOCATION (Z/L):	0.945	0.969	0.98
TAP LOCATION (Z/D):	5.303	5.438	5.5
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
0.0	-0.421	-0.375	-0.368
10.0	-0.428	-0.371	-0.375
20.0	-0.435	-0.362	-0.383
30.0	-0.450	-0.397	-0.399
40.0	-0.471	-0.418	-0.414
50.0	-0.492	-0.436	-0.416
60.0	-0.518	-0.455	-0.411
70.0	-0.533	-0.458	-0.350
80.0	-0.542	-0.411	-0.269
90.0	-0.536	-0.333	-0.187
100.0	-0.524	-0.250	-0.137
110.0	-0.468	-0.177	-0.110
120.0	-0.318	-0.143	-0.087
130.0	-0.255	-0.123	-0.081
140.0	-0.231	-0.117	-0.076
150.0	-0.229	-0.109	-0.073
160.0	-0.227	-0.087	-0.069
170.0	-0.200	-0.068	-0.054
180.0	-0.168	-0.055	-0.024
190.0	-0.183	-0.055	-0.066
200.0	-0.208	-0.088	-0.083
210.0	-0.224	-0.110	-0.092
220.0	-0.237	-0.120	-0.094
230.0	-0.272	-0.131	-0.094
240.0	-0.307	-0.142	-0.095
250.0	-0.365	-0.153	-0.101
260.0	-0.481	-0.190	-0.109
270.0	-0.520	-0.278	-0.131
280.0	-0.537	-0.368	-0.227
290.0	-0.536	-0.422	-0.330
300.0	-0.526	-0.449	-0.400
310.0	-0.503	-0.449	-0.420
320.0	-0.483	-0.425	-0.424
330.0	-0.457	-0.407	-0.409
340.0	-0.436	-0.391	-0.387
350.0	-0.427	-0.379	-0.373

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	ON	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	10	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

Figure A-9. (Cont'd)

DATA SOURCE : LANGLEY

TAP LOCATION (Z/L):	0.07	0.16	0.28	0.4	0.5
TAP LOCATION (Z/D):	0.393	0.898	1.571	2.245	2.806
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************
0.0	0.272	0.172	0.083	0.000	-0.322
22.5	0.249	0.149	0.061	-0.020	-0.339
45.0	0.185	0.087	0.002	-0.075	-0.383
67.5	0.103	0.008	-0.071	-0.142	-0.445
90.0	0.035	-0.056	-0.125	-0.187	-0.468
112.5	0.000	-0.084	-0.136	-0.199	-0.486
135.0	-0.003	-0.081	-0.130	-0.184	-0.471
157.5	0.006	-0.072	-0.118	-0.164	-0.446
180.0	0.013	-0.059	-0.098	-0.152	-0.447
202.5	0.006	-0.072	-0.118	-0.164	-0.446
225.0	-0.003	-0.081	-0.130	-0.184	-0.471
247.5	0.000	-0.084	-0.136	-0.199	-0.486
270.0	0.035	-0.056	-0.125	-0.187	-0.468
292.5	0.103	0.008	-0.071	-0.142	-0.445
315.0	0.185	0.087	0.002	-0.075	-0.383
337.5	0.249	0.149	0.061	-0.020	-0.339

REF. LENGTH (L): 44.616 IN.
REF. DIAMETER (D): 7.95 IN.
ROTATING BAND: ON
MACH NO.: 0.94
ANGLE OF ATTACK (ALPHA): 10 DEG.
SPIN RATE (P): 4900 REV/MIN
TIP SPEED RATIO (PD/2V): 0.162027427
X CG/L 0.625112067

DATA SOURCE : AMES

TAP LOCATION (Z/L):	0.503	0.526	0.537	0.548	0.571	0.615	0.66	0.705
TAP LOCATION (Z/D):	2.824	2.95	3.014	3.077	3.203	3.454	3.706	3.957
CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
***************	***************	***************	***************	***************	***************	***************	***************	***************
0.0	-0.025	-0.039	-0.249	-0.340	-0.255	-0.139	-0.023	0.013
10.0	-0.027	-0.042	-0.255	-0.339	-0.256	-0.140	-0.024	0.011
20.0	-0.030	-0.055	-0.266	-0.350	-0.270	-0.151	-0.032	0.000
30.0	-0.055	-0.075	-0.282	-0.367	-0.291	-0.172	-0.052	-0.015
40.0	-0.097	-0.101	-0.300	-0.387	-0.318	-0.193	-0.068	-0.039
50.0	-0.117	-0.131	-0.330	-0.411	-0.345	-0.213	-0.081	-0.058
60.0	-0.155	-0.157	-0.356	-0.434	-0.377	-0.237	-0.096	-0.090
70.0	-0.179	-0.187	-0.380	-0.460	-0.407	-0.257	-0.106	-0.096
80.0	-0.204	-0.211	-0.410	-0.489	-0.428	-0.269	-0.109	-0.104
90.0	-0.226	-0.229	-0.419	-0.492	-0.449	-0.277	-0.105	-0.106
100.0	-0.231	-0.241	-0.432	-0.504	-0.0458	-0.279	-0.100	-0.098
110.0	-0.236	-0.246	-0.436	-0.502	-0.465	-0.276	-0.086	-0.083
120.0	-0.229	-0.244	-0.442	-0.500	[illegible]	-0.268	-0.078	-0.065
130.0	-0.221	-0.241	-0.442	-0.509	-0.439	-0.251	-0.062	-0.053
140.0	-0.212	-0.241	-0.441	-0.569	-0.423	-0.239	-0.055	-0.048
150.0	-0.202	-0.241	-0.431	-0.551	-0.410	-0.229	-0.047	-0.041
160.0	-0.198	-0.231	-0.426	-0.540	-0.401	-0.220	-0.029	-0.028
170.0	-0.187	-0.220	-0.417	-0.538	-0.389	-0.199	-0.008	-0.006
180.0	-0.185	-0.216	-0.419	-0.538	-0.381	-0.191	0.000	-0.006
190.0	-0.181	-0.226	-0.418	-0.436	-0.388	-0.197	-0.005	0.007
200.0	-0.190	-0.227	-0.419	-0.440	-0.397	-0.204	-0.011	-0.001
210.0	-0.200	-0.219	-0.427	-0.453	-0.416	-0.219	-0.022	-0.012
220.0	-0.211	-0.222	-0.427	-0.479	-0.434	-0.236	-0.038	-0.036
230.0	-0.228	-0.232	-0.433	-0.490	-0.459	-0.258	-0.057	-0.051
240.0	-0.239	-0.240	-0.435	-0.500	-0.470	-0.272	-0.073	-0.076
250.0	-0.244	-0.243	-0.435	-0.506	-0.471	-0.280	-0.089	-0.098
260.0	-0.242	-0.241	-0.432	-0.507	-0.474	-0.287	-0.099	-0.109
270.0	-0.229	-0.234	-0.422	-0.507	-0.465	-0.288	-0.11	-0.113
280.0	-0.210	-0.223	-0.412	-0.489	-0.448	-0.283	-0.117	-0.114
290.0	-0.191	-0.196	-0.387	-0.468	-0.418	-0.267	-0.115	-0.101
300.0	-0.160	-0.167	-0.361	-0.451	-0.394	-0.257	-0.119	-0.087
310.0	-0.129	-0.139	-0.335	-0.429	-0.364	-0.235	-0.105	-0.063
320.0	-0.099	-0.109	-0.307	-0.398	-0.333	-0.211	-0.088	-0.044
330.0	-0.072	-0.078	-0.283	-0.375	-0.301	-0.181	-0.061	-0.018
340.0	-0.048	-0.055	-0.262	-0.351	-0.277	-0.161	-0.045	-0.001
350.0	-0.030	-0.041	-0.251	-0.343	-0.265	-0.148	-0.030	0.012

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
TAP LOCATION (Z/L):	0.75	0.848	0.859	0.87	0.888	0.899	0.91	0.922
TAP LOCATION (Z/D):	4.289	4.757	4.82	4.883	4.983	5.046	5.109	5.176
***************	***************	***************	***************	***************	***************	***************	***************	***************
0.0	0.011	-0.009	-0.107	-0.106	-0.104	-0.121	-0.494	-0.442
10.0	0.008	-0.010	-0.105	-0.105	-0.104	-0.125	-0.497	-0.443
20.0	0.002	-0.019	-0.106	-0.106	-0.105	-0.134	-0.504	-0.448
30.0	-0.012	-0.036	-0.106	-0.109	-0.112	-0.148	-0.515	-0.461
40.0	-0.030	-0.059	-0.106	-0.111	-0.115	-0.166	-0.537	-0.491
50.0	-0.044	-0.061	-0.105	-0.113	-0.121	-0.196	-0.561	-0.505
60.0	-0.057	-0.103	-0.108	-0.120	-0.132	-0.232	-0.584	-0.531
70.0	-0.075	-0.121	-0.114	-0.131	-0.148	-0.265	-0.602	-0.547
80.0	-0.086	-0.134	-0.132	-0.148	-0.164	-0.291	-0.617	-0.556
90.0	-0.085	-0.137	-0.156	-0.168	-0.180	-0.295	-0.626	-0.543
100.0	-0.079	-0.130	-0.166	-0.174	-0.181	-0.296	-0.621	-0.507
110.0	-0.067	-0.120	-0.175	-0.176	-0.176	-0.299	-0.613	-0.479
120.0	-0.055	-0.111	-0.182	-0.178	-0.173	-0.307	-0.604	-0.455
130.0	-0.052	-0.110	-0.189	-0.184	-0.178	-0.319	-0.599	-0.445
140.0	-0.048	-0.121	-0.198	-0.198	-0.198	-0.321	-0.649	-0.464
150.0	-0.043	-0.119	-0.201	-0.219	-0.237	-0.317	-0.658	-0.455
160.0	-0.025	-0.087	-0.202	-0.221	-0.239	-0.304	-0.615	-0.418
170.0	-0.016	-0.065	-0.201	-0.214	-0.227	-0.289	-0.596	-0.397
180.0	-0.001	-0.064	-0.206	-0.211	-0.215	-0.271	-0.600	-0.390
190.0	0.004	-0.070	-0.240	-0.229	-0.218	-0.297	-0.599	-0.391
200.0	-0.002	-0.076	-0.218	-0.218	-0.217	-0.315	-0.599	-0.396
210.0	-0.008	-0.086	-0.207	-0.206	-0.204	-0.312	-0.592	-0.402
220.0	-0.024	-0.099	-0.240	-0.216	-0.191	-0.307	-0.597	-0.415
230.0	-0.044	-0.115	-0.256	-0.222	-0.187	-0.308	-0.602	-0.441
240.0	-0.063	-0.134	-0.248	-0.218	-0.188	-0.317	-0.607	-0.484
250.0	-0.079	-0.149	-0.235	-0.213	-0.190	-0.327	-0.615	-0.543
260.0	-0.093	-0.160	-0.221	-0.207	-0.193	-0.333	-0.625	-0.571
270.0	-0.098	-0.162	-0.207	-0.197	-0.187	-0.322	-0.679	-0.581
280.0	-0.097	-0.156	-0.186	-0.184	-0.182	-0.306	-0.617	-0.577
290.0	-0.089	-0.141	-0.171	-0.171	-0.171	-0.276	-0.604	-0.564
300.0	-0.076	-0.123	-0.159	-0.160	-0.160	-0.257	-0.581	-0.540
310.0	-0.059	-0.100	-0.152	-0.151	-0.149	-0.224	-0.561	-0.511
320.0	-0.036	-0.072	-0.147	-0.146	-0.145	-0.193	-0.541	-0.485
330.0	-0.029	-0.044	-0.139	-0.140	-0.141	-0.161	-0.522	-0.465
340.0	0.000	-0.024	-0.121	-0.124	-0.126	-0.139	-0.507	-0.453
350.0	0.006	-0.011	-0.112	-0.111	-0.110	-0.124	-0.494	-0.444

CIRCUMFERENTIAL ANGLE (PHI)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)	PRESSURE COEFFICIENT (CP)
TAP LOCATION (Z/L):	0.945	0.969	0.98
TAP LOCATION (Z/D):	5.303	5.438	5.5
***************	***************	***************	***************
0.0	-0.389	-0.161	-0.106
10.0	-0.389	-0.167	-0.106
20.0	-0.392	-0.175	-0.106
30.0	-0.406	-0.184	-0.114
40.0	-0.425	-0.183	-0.122
50.0	-0.448	-0.176	-0.137
60.0	-0.477	-0.166	-0.148
70.0	-0.491	-0.152	-0.138
80.0	-0.494	-0.132	-0.125
90.0	-0.459	-0.113	-0.115
100.0	-0.393	-0.104	-0.105
110.0	-0.344	-0.095	-0.100
120.0	-0.305	-0.087	-0.096
130.0	-0.290	-0.084	-0.096
140.0	-0.278	-0.082	-0.092
150.0	-0.251	-0.078	-0.078
160.0	-0.221	-0.061	-0.061
170.0	-0.197	-0.051	-0.049
180.0	-0.180	-0.041	-0.043
190.0	-0.183	-0.051	-0.073
200.0	-0.192	-0.059	-0.073
210.0	-0.211	-0.068	-0.076
220.0	-0.233	-0.073	-0.077
230.0	-0.280	-0.080	-0.077
240.0	-0.361	-0.086	-0.078
250.0	-0.471	-0.096	-0.079
260.0	-0.517	-0.108	-0.086
270.0	-0.532	-0.127	-0.095
280.0	-0.537	-0.137	-0.105
290.0	-0.523	-0.145	-0.111
300.0	-0.499	-0.144	-0.118
310.0	-0.461	-0.143	-0.120
320.0	-0.428	-0.144	-0.120
330.0	-0.407	-0.146	-0.119
340.0	-0.399	-0.152	-0.116
350.0	-0.393	-0.158	-0.110

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
POTATING BAND:	ON	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	10	DEG.
SPIN RATE (P):	4900	REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427	
X CG/L	0.625112067	

Figure A-10. (Cont'd)

APPENDIX B

PLOTTED WIND TUNNEL TEST DATA

This appendix contains the measured pressure data in plotted format. Each set of plots relates to a specific model configuration and test condition with data for both the spinning and non-spinning cases presented on each plot. The appendix figures include the following data:

Figure	Rotating band	Angle of attack (deg)	Spin rate (rpm)
B1	OFF	0	0, 4900
B2	OFF	4	0, 4900
B3	OFF	10	0, 4900
B4	ON	0	0, 4900
B5	ON	10	0, 4900

Because of the computer format, some of the terms in Appendix B are different from those of the main report text. The following define these terms:

Term	Symbol used in report text
P-P STATIC	ΔP
C.P.	C_p
PHI	ϕ

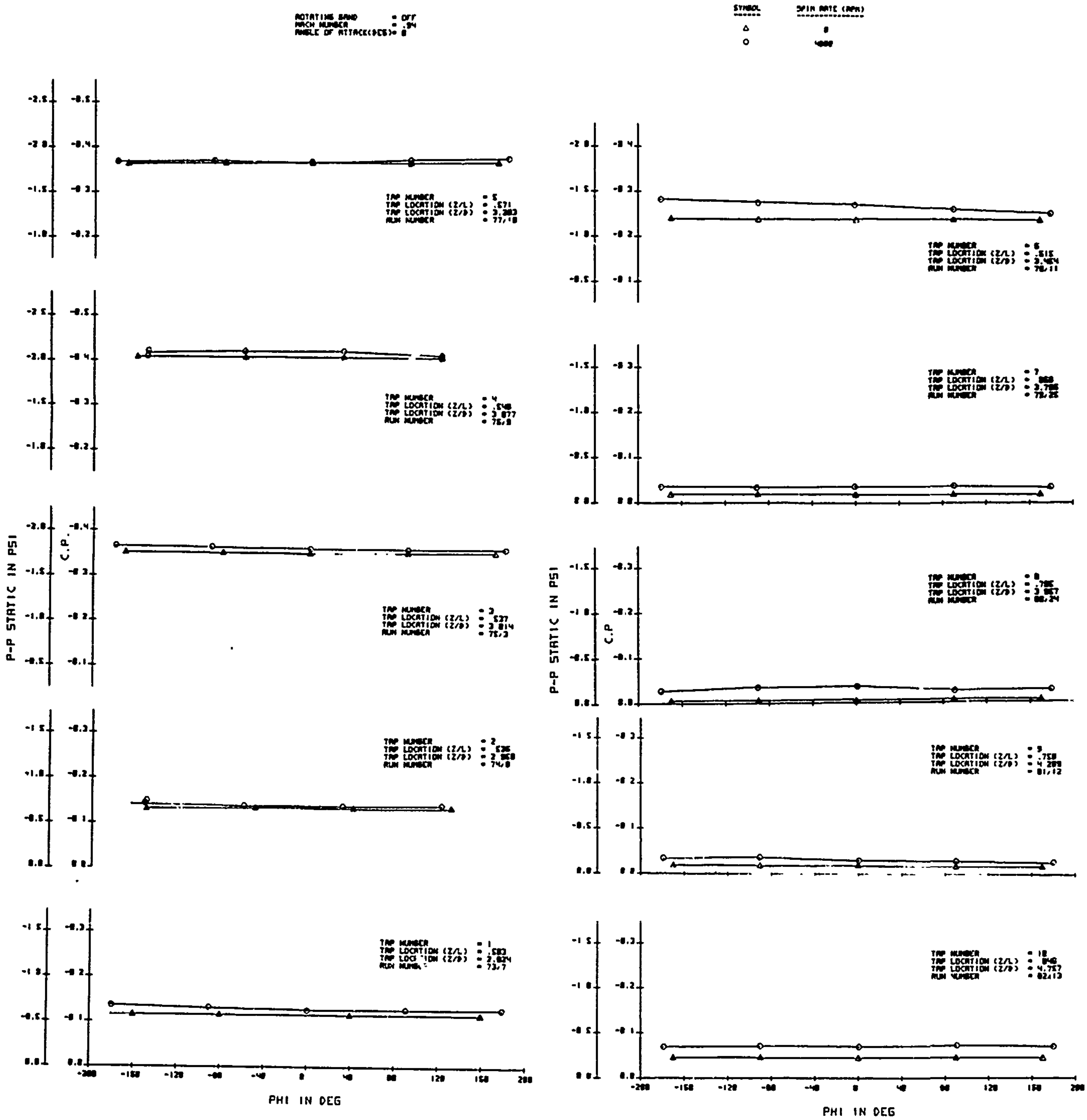

Figure B-1. Rotating Band Off, α = 0°

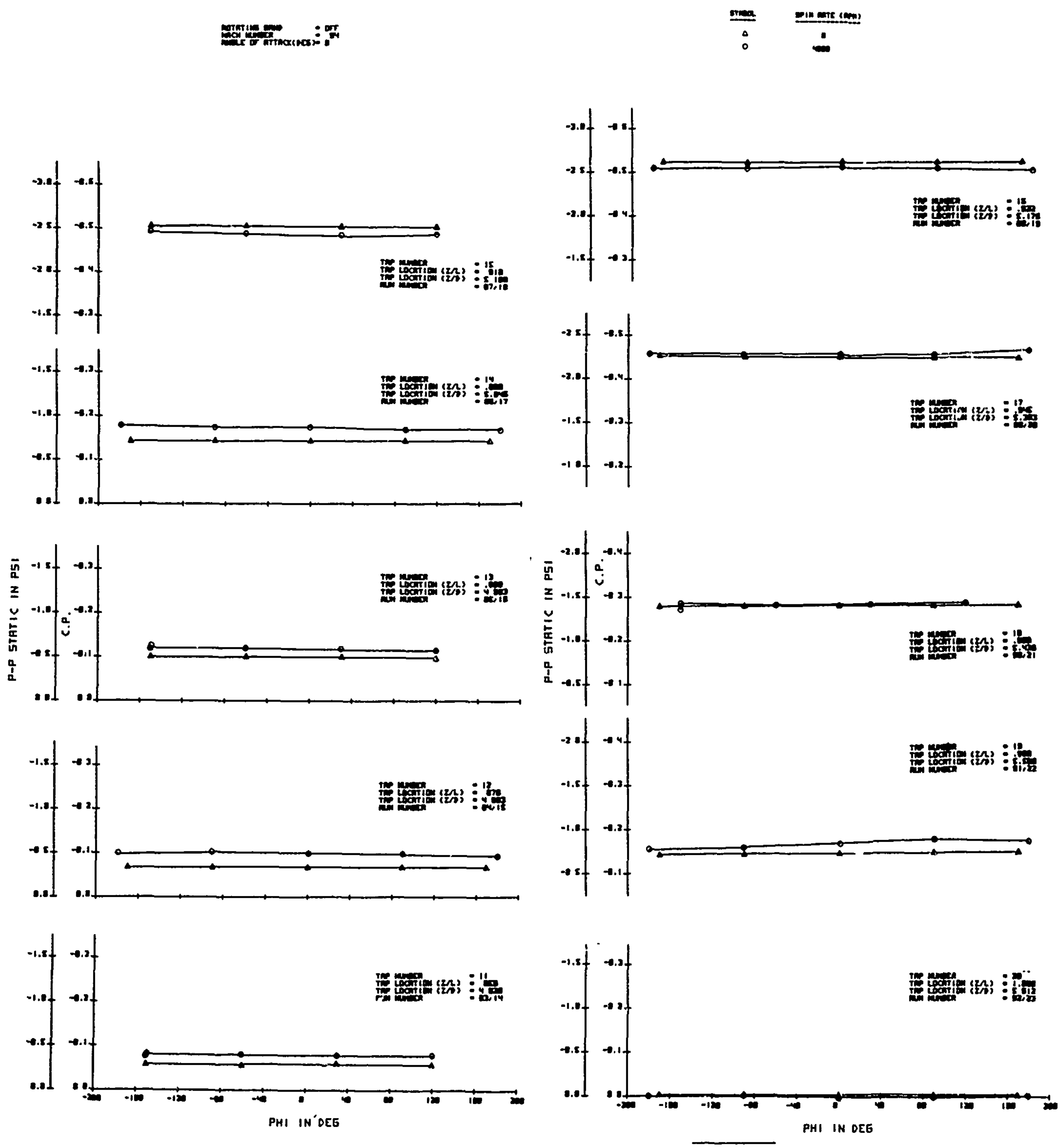

Figure B-1 (Continued)

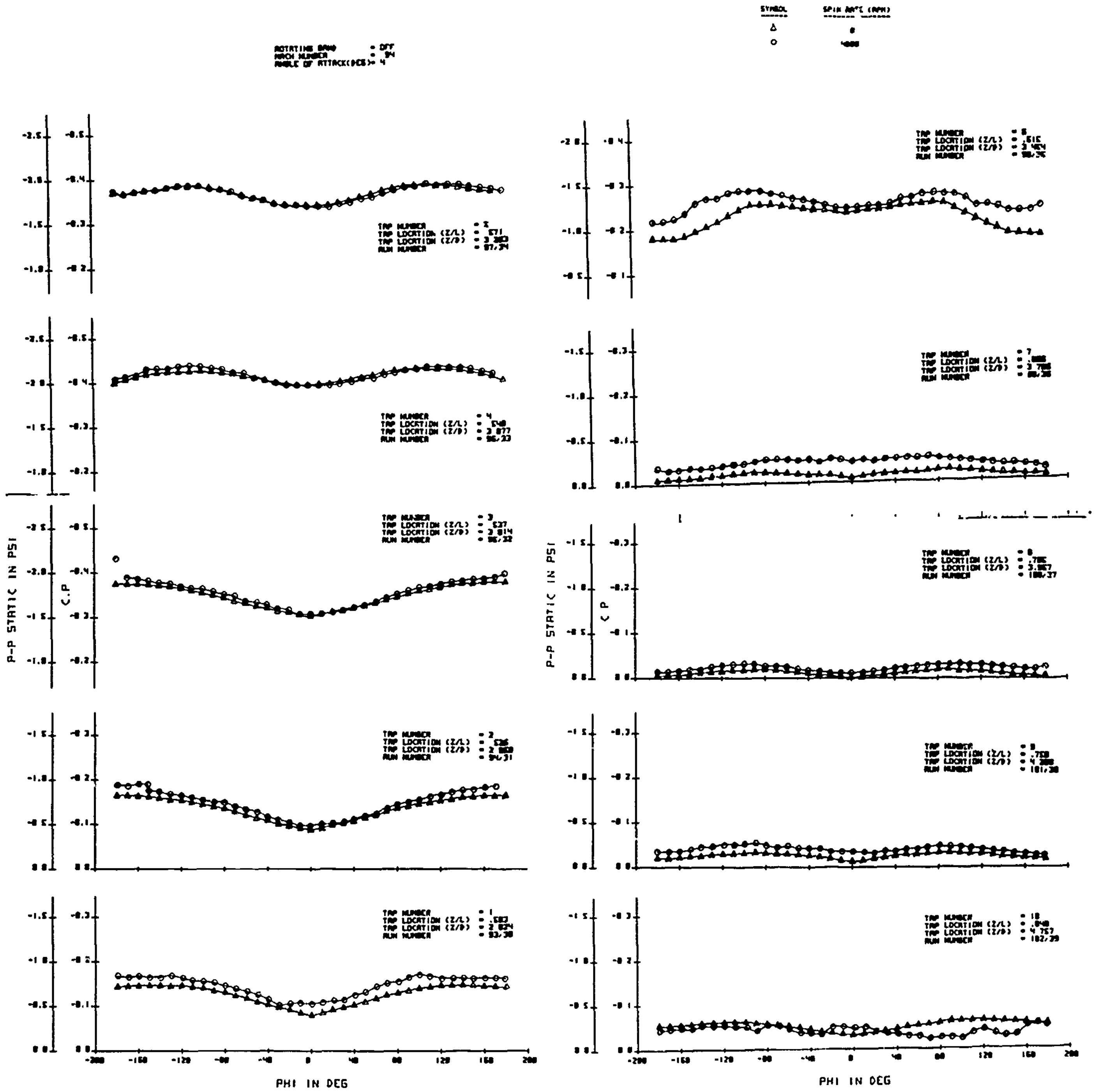

Figure B-2. Rotating Band Off, α = 4°

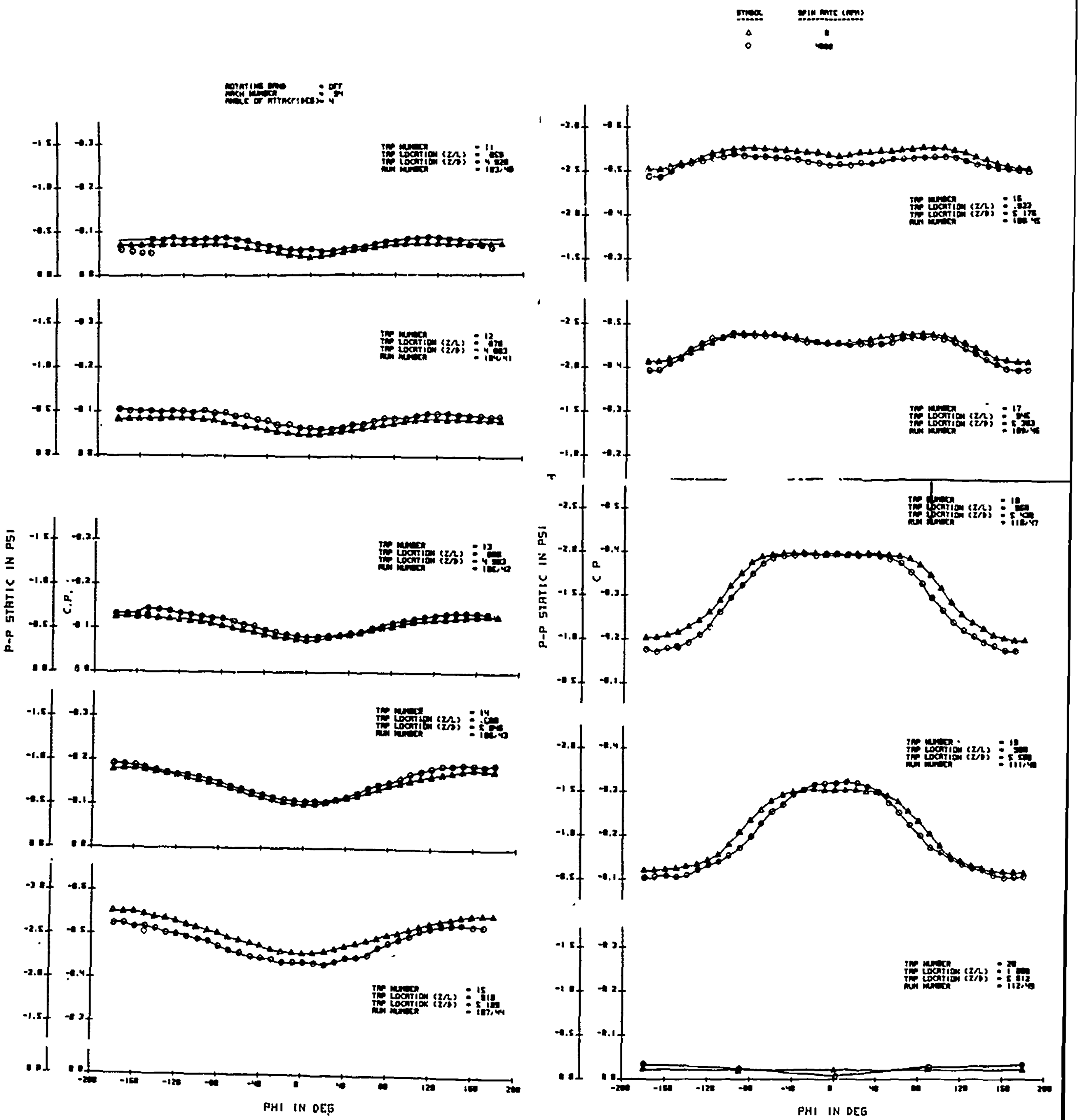

Figure B-2 (Continued)

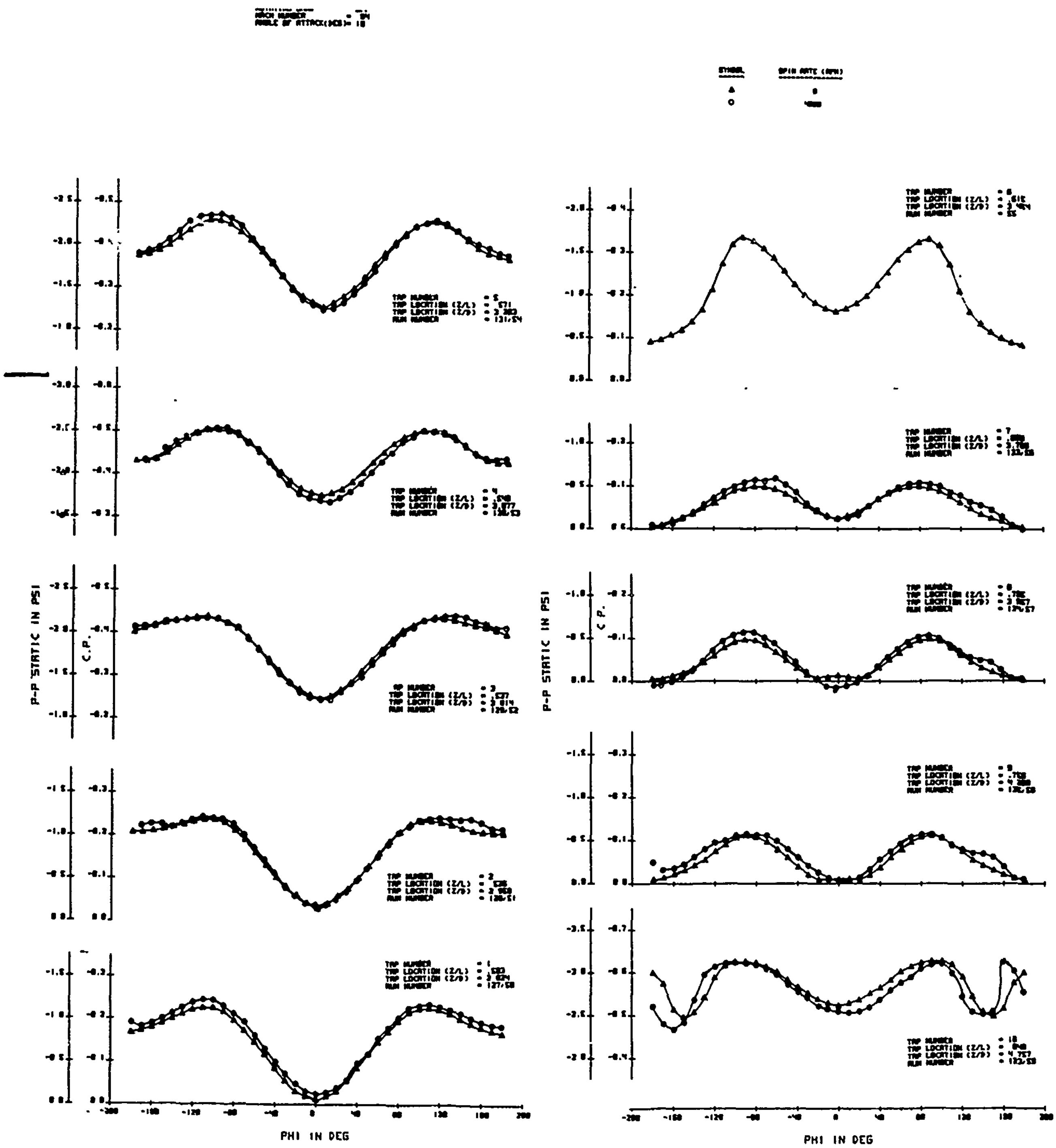

Figure B-3. Rotating Band Off, $\alpha = 10°$

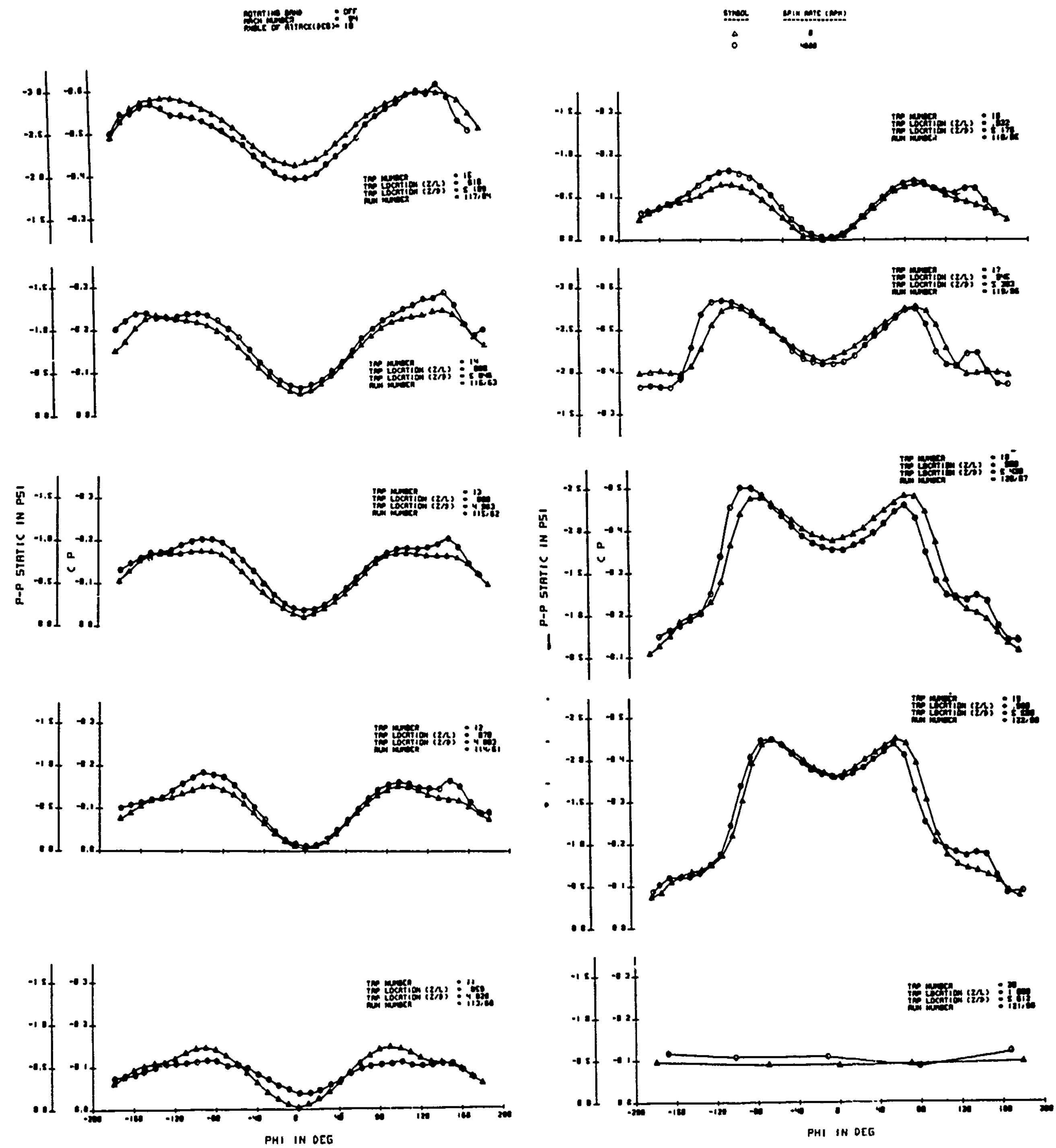

Figure B-3 (Continued)

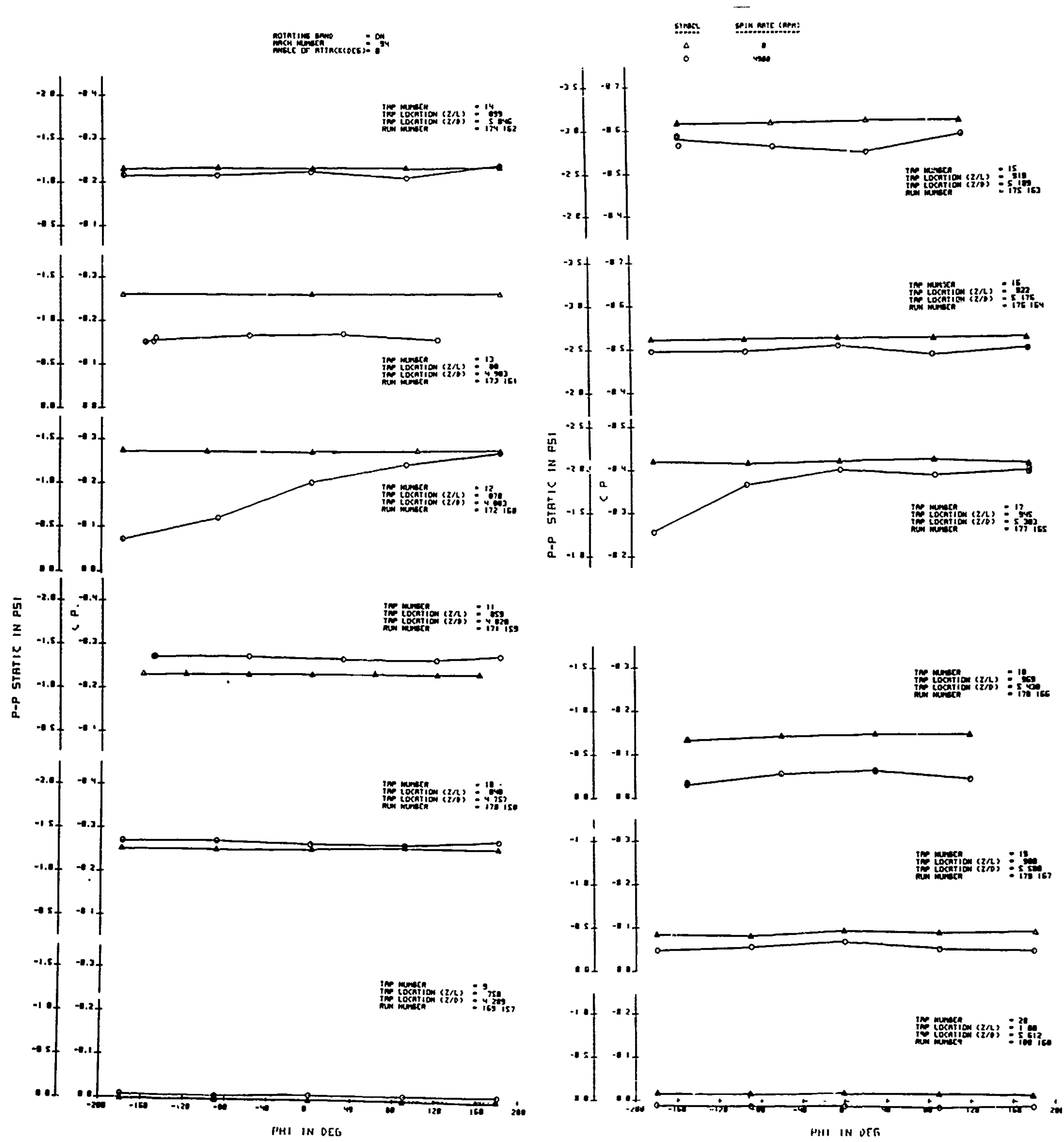

Figure B-4. Rotating Band On, α = 0°

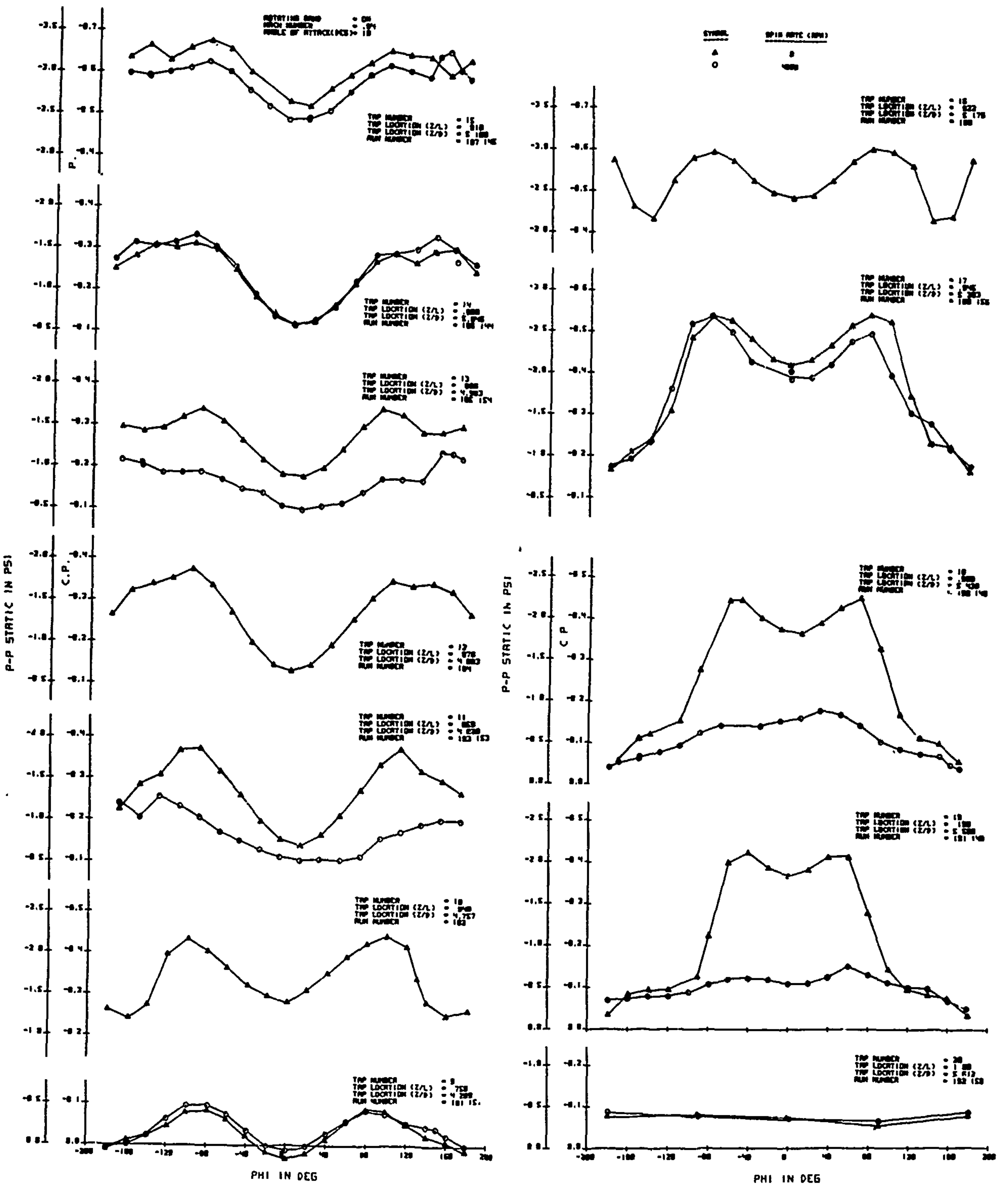

Figure B-5. Rotating Band On, $\alpha = 10°$

APPENDIX C

FORCE AND MOMENT TERMS
COMPUTED FROM SURFACE PRESSURE DATA

This appendix contains both local and total force and moment coefficients and related terms as computed from the measured surface pressure data. Each set of data relates to a specific model configuration and test condition as follows:

Figure	Rotating band	Angle of attack (deg)	Spin rate (rpm)
C1	OFF	0	0
C2	OFF	0	4900
C3	OFF	4	0
C4	OFF	4	4900
C5	OFF	10	0
C6	OFF	10	4900
C7	ON	0	0
C8	ON	0	4900
C9	ON	10	0
C10	ON	10	4900

These data indicate the total coefficient values as well as the contribution to the coefficient values due to the nose, cylinder, and boattail portions of model where:

Portion	Region (Z/L)
nose	0 to .537
cylinder	.537 to .910
boattail	.910 to 1.00

The terms are listed for the longitudinal location at which they were computed. Because of the computer format, some of the terms are different from those in the main report text. The following define these terms:

Terms	Symbol used in report text	Definition (if not in report text)
XCG/L	X_{cg}/L	
ZI/L	Z_i/L	
ZI	Z_i	
DZI	ΔZ_i	
DIA	d_i	Diameter of model at Z_i
CNI LOCAL	C_N	Local normal force coefficient normal to local surface
CN	C_{N_i}	Local normal force coefficient normal to longitudinal (Z) axis
C SUM	$\sum C_{N_i}$	Summation of local normal force coefficients from nose
CM	C_{M_i}	Local pitching moment coefficient
CYI LOCAL	C_{Y_i}	Local side (Magnus) force coefficient normal to local surface
CY SUM	$\sum C_Y$	Summation of local side (Magnus) force coefficients from nose
Cn	C_{n_i}	Local yawing (Magnus) moment coefficient
NORMAL FORCE COEFFICIENT	C_N	Total normal force coefficient
PITCHING MOMENT	C_M	Total pitching moment
COEFFICIENT (NOSE)		Coefficient referred to tip of nose (Z/L = 0)
PITCHING MOMENT COEFFICIENT (CG)		Total pitching moment coefficient referred to Ref C.G. (Z/L = .625)
NORMAL FORCE COEFFICIENT (NOSE)		Normal force coefficient due to nose portion of model
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE)		Pitching moment coefficient due to nose portion of model referred to tip of nose (Z/L = 0)

PITCHING MOMENT COEFFICIENT (CG) (NOSE)	Pitching moment coefficient due to nose portion of model referred to Ref C.G. (Z/L = .625)
NORMAL FORCE COEFFICIENT (CYL)	Normal force coefficient due to cylindrical portion of model
PITCHING MOMENT COEFFICIENT (CYL) (NOSE)	Pitching moment coefficient due to cylindrical portion of model referred to tip of nose (Z/L = 0)
PITCHING MOMENT COEFFICIENT (CG) (CYL)	Pitching moment coefficient due to cylindrical portion of model referred to Ref C.G. (Z/L = .625)
NORMAL FORCE COEFFICIENT (BT)	Normal force coefficient due to boattail portion of model
PITCHING MOMENT COEFFICIENT (NOSE) (BT)	Pitching moment coefficient due to boattail portion of model referred to tip of nose (Z/L = 0)
PITCHING MOMENT COEFFICIENT (CG) (BT)	Pitching moment coefficient due to boattail portion of model referred to Ref C.G. (Z/L = .625)

REF. LENGTH (L): 44.616 IN.
REF. DIAMETER (D): 7.95 IN.
ROTATING BAND: OFF
MACH NO.: 0.94
ANGLE OF ATTACK (ALPHA): 0 DEG.
SPIN RATE (P): 0 REV/MIN
TIP SPEED RATIO (PD/2V): 0
X CG/L 0.625112067

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.970	3.123	5.130	2.125	-0.0003	0.0003	-0.0003	-0.0001
0.160	7.139	4.685	3.812	-0.0004	-0.0004	-0.0007	-0.0005
0.280	12.492	5.354	5.375	-0.0006	-0.0005	-0.0013	-0.0014
0.400	17.846	4.908	6.875	-0.0007	-0.0006	-0.0019	-0.0028
0.500	22.308	2.302	7.718	0.0001	0.0001	-0.0018	-0.0024
0.503	22.449	0.571	7.750	0.0000	0.0000	-0.0018	-0.0024
0.526	23.450	0.756	7.937	0.0000	0.0000	-0.0018	-0.0024
0.537	23.961	0.506	7.950	0.0000	0.0000	-0.0018	-0.0024
0.548	24.461	0.750	7.950	0.0000	0.0000	-0.0018	-0.0024
0.571	25.461	1.500	7.950	0.0000	0.0000	-0.0018	-0.0024
0.615	27.461	2.000	7.950	0.0000	0.0000	-0.0018	-0.0024
0.660	29.461	2.000	7.950	0.0000	0.0000	-0.0018	-0.0024
0.705	31.461	2.000	7.950	0.0000	0.0000	-0.0018	-0.0024
0.750	33.461	3.180	7.950	0.0000	0.0000	-0.0018	-0.0024
0.848	37.821	2.430	7.950	0.0000	0.0000	-0.0018	-0.0024
0.859	38.321	0.300	7.950	0.0000	0.0000	-0.0016	-0.0024
0.870	38.821	0.648	7.950	0.0000	0.0000	-0.0018	-0.0024
0.888	39.616	0.648	7.950	0.0000	0.0000	-0.0018	-0.0024
0.899	40.116	0.500	7.950	0.0000	0.0000	-0.0018	-0.0024
0.910	40.616	0.518	7.950	0.0000	0.0000	-0.0018	-0.0024
0.922	41.151	0.772	7.875	0.0000	0.0000	-0.0018	-0.0024
0.945	42.159	1.043	7.625	0.0000	0.0000	-0.0018	-0.0024
0.969	43.236	0.783	7.375	0.0000	0.0000	-0.0018	-0.0024
0.980	43.725	0.690	7.259	0.0000	0.0000	-0.0018	-0.0024

NORMAL FORCE COEFFICIENT =-1.79196E-03
PITCHING MOMENT COEFFICIENT (NOSE) =-2.42109E-03
PITCHING MOMENT COEFFICIENT (CG) =-3.06544E-03

NORMAL FORCE COEFFICIENT (NOSE) =-1.79196E-03
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE) =-2.42109E-03
PITCHING MOMENT COEFFICIENT (CG) (NOSE) =-3.86544E-03

NORMAL FORCE COEFFICIENT (CYL) = 4.31000E-12
PITCHING MOMENT COEFFICIENT (NOSE) (CYL) = 1.61200E-11
PITCHING MOMENT COEFFICIENT (CG) (CYL) =-9.99761E-13

NORMAL FORCE COEFFICIENT (BT) = 2.06000E-12
PITCHING MOMENT COEFFICIENT (NOSE) (BT) = 1.09800E-11
PITCHING MOMENT COEFFICIENT (CG) (BT) =-3.75316E-12

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.160	7.139	4.685	3.812	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.280	12.492	5.354	5.375	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.400	17.846	4.908	6.875	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.500	22.308	2.302	7.718	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.593	22.449	0.571	7.750	4.33E-14	4.32E-14	4.32E-14	1.22E-13
0.526	23.450	0.756	7.937	-1.09E-13	-1.09E-13	-6.56E-14	-1.99E-13
0.537	23.961	0.506	7.950	-2.04E-13	-2.04E-13	-2.69E-13	-8.13E-13
0.548	24.461	0.750	7.950	-4.17E-14	-4.17E-14	-3.11E-13	-9.42E-13
0.571	25.461	1.500	7.950	-1.40E-13	-1.40E-13	-4.51E-13	-1.39E-12
0.615	27.461	2.000	7.950	-3.34E-14	-3.34E-14	-4.84E-13	-1.50E-12
0.660	29.461	2.000	7.950	-2.64E-14	-2.64E-14	-5.11E-13	-1.60E-12
0.705	31.461	2.000	7.950	-1.08E-14	-1.08E-14	-5.22E-13	-1.65E-12
0.750	33.461	3.180	7.950	-3.27E-14	-3.27E-14	-5.54E-13	-1.78E-12
0.848	37.821	2.130	7.950	-5.78E-14	-5.78E-14	-6.12E-13	-2.06E-12
0.859	38.321	0.500	7.950	-2.83E-14	-2.83E-14	-6.40E-13	-2.19E-12
0.870	38.821	0.648	7.959	-3.78E-14	-3.78E-14	-6.78E-13	-2.38E-12
0.888	39.616	0.646	7.950	-1.80E-15	-1.80E-15	-6.80E-13	-2.39E-12
0.899	40.116	0.500	7.950	1.02E-13	1.02E-13	-5.73E-13	-1.88E-12
0.910	40.616	0.518	7.950	-1.90E-13	-1.90E-13	-7.68E-13	-2.85E-12
0.922	41.151	0.772	7.875	-3.63E-13	-3.60E-13	-1.13E-12	-4.71E-12
0.945	42.159	1.043	7.625	-4.56E-13	-4.52E-13	-1.58E-12	-7.11E-12
0.969	43.236	0.783	7.375	-2.32E-14	-2.30E-14	-1.60E-12	-7.23E-12
0.980	43.725	0.690	7.250	1.11E-13	1.10E-13	-1.49E-12	-6.63E-12

MAGNUS FORCE COEFFICIENT =-1.49360E-12
MAGNUS MOMENT COEFFICIENT (NOSE) =-6.62764E-12
MAGNUS MOMENT COEFFICIENT (CG) = 1.38784E-12

MAGNUS FORCE COEFFICIENT (NOSE) =-2.69449E-13
MAGNUS MOMENT COEFFICIENT (NOSE) (NOSE) =-8.13333E-13
MAGNUS MOMENT COEFFICIENT (CG) (NOSE) =-1.31941E-13

MAGNUS FORCE COEFFICIENT (CYL) =-4.98988E-13
MAGNUS MOMENT COEFFICIENT (NOSE) (CYL) =-2.03302E-12
MAGNUS MOMENT COEFFICIENT (CG) (CYL) = 2.82487E-13

MAGNUS FORCE COEFFICIENT (BT) =-7.25160E-13
MAGNUS MOMENT COEFFICIENT (NOSE) (BT) =-3.78129E-12
MAGNUS MOMENT COEFFICIENT (CG) (BT) = 1.23730E-12

Figure C-1. Rotating Band Off, α = 0° P = 0 rpm

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	OFF
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	0 DEG.
SPIN RATE (P):	4900 REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427
X CG/L	0.625112067

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	-0.0003	-0.0003	-0.0003	-0.0001
0.160	7.139	4.685	3.812	-0.0004	-0.0004	-0.0007	-0.0005
0.280	12.492	5.354	5.375	-0.0006	-0.0005	-0.0013	-0.0014
0.400	17.846	4.908	6.875	-0.0007	-0.0006	-0.0019	-0.0028
0.500	22.308	2.302	7.718	0.0001	0.0001	-0.0018	-0.0024
0.503	22.449	0.571	7.750	0.0004	0.0004	-0.0014	-0.0013
0.526	23.450	0.756	7.937	0.0000	0.0000	-0.0014	-0.0013
0.537	23.961	0.506	7.950	0.0000	0.0000	-0.0014	-0.0013
0.548	24.461	0.750	7.950	-0.0003	-0.0003	-0.0017	-0.0022
0.571	25.461	1.500	7.950	0.0007	0.0007	-0.0009	0.0002
0.615	27.461	2.000	7.950	-0.0013	-0.0013	-0.0022	-0.0043
0.660	29.461	2.000	7.950	0.0000	0.0000	-0.0022	-0.0043
0.705	31.461	2.000	7.950	-0.0012	-0.0012	-0.0034	-0.0088
0.750	33.461	3.180	7.950	-0.0004	-0.0004	-0.0038	-0.0107
0.848	37.821	2.430	7.950	0.0000	0.0000	-0.0038	-0.0107
0.859	38.321	0.500	7.950	0.0000	0.0000	-0.0038	-0.0107
0.870	38.821	0.648	7.950	-0.0003	-0.0003	-0.0041	-0.0121
0.888	39.616	0.648	7.950	0.0000	0.0000	-0.0041	-0.0121
0.899	40.116	0.500	7.950	0.0000	0.0000	-0.0041	-0.0119
0.910	40.616	0.518	7.950	0.0002	0.0002	-0.0039	-0.0108
0.922	41.151	0.772	7.875	-0.0004	-0.0004	-0.0042	-0.0127
0.945	42.159	1.043	7.625	0.0000	0.0000	-0.0042	-0.0127
0.969	43.236	0.783	7.375	-0.0002	-0.0002	-0.0344	-0.0138
0.980	43.725	0.690	7.250	0.0001	0.0001	-0.0043	-0.0133

NORMAL	FORCE COEFFICIENT	=-4.34259E-03
PITCHING	MOMENT COEFFICIENT (NOSE)	=-0.013313269
PITCHING	MOMENT COEFFICIENT (CG)	=-1.92129E-03
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	=-0.026801552
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RPTE	=-0.011857803
NORMAL	FORCE COEFFICIENT (NOSE)	=-1.39728E-03
PITCHING	MOMENT COEFFICIENT (NOSE) (NOSE)	=-1.30473E-03
PITCHING	MOMENT COEFFICIENT (CG) (NOSE)	=-3.59718E-03
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	=-8.62373E-03
MOMENT	COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	=-0.022201040
NORMAL	FORCE COEFFICIENT (CYL)	=-2.46248E-03
PITCHING	MOMENT COEFFICIENT (NOSE) (CYL)	=-9.48355E-03
PITCHING	MOMENT COEFFICIENT (CG) (CYL)	= 8.44745E-04
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	=-0.015197904
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	= 5.21359E-03
NORMAL	FORCE COEFFICIENT (BT)	=-4.82828E-04
PITCHING	MOMENT COEFFICIENT (NOSE) (BT)	=-2.52499E-03
PITCHING	MOMENT COEFFICIENT (CG) (BT)	= 8.31143E-04
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	=-2.97991E-03
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	= 5.12965E-03

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.160	7.139	4.685	3.812	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.280	12.492	5.354	5.375	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.400	17.846	4.908	6.875	0.00E+00	0.09E+00	0.00E+00	0.00E+00
0.500	22.308	2.302	7.718	0.00E+00	0.09E+00	0.09E+00	0.00E+00
0.503	22.449	0.571	7.750	2.40E-04	2.39E-04	2.39E-04	6.75E-04
0.526	23.450	0.756	7.937	-1.09E-13	-1.09E-13	2.39E-04	6.75E-04
0.537	23.961	0.506	7.950	6.46E-05	6.46E-05	3.04E-04	8.70E-04
0.518	24.461	0.750	7.950	4.15E-04	4.15E-04	7.18E-04	2.15E-03
0.571	25.461	1.500	7.950	-5.11E-04	-5.11E-04	2.07E-04	5.08E-04
0.615	27.461	2.000	7.950	4.75E-03	4.75E-03	4.96E-03	1.69E-02
0.660	29.461	2.000	7.950	-2.14E-14	-2.14E-14	4.96E-03	1.69E-02
0.705	31.461	2.000	7.950	1.63E-03	1.63E-63	6.59E-03	2.34E-02
0.750	33.461	3.180	7.950	1.61E-03	1.61E-03	8.20E-03	3.01E-02
0.848	37.821	2.430	7.950	-1.45E-13	-1.45E-13	8.20E-03	3.01E-02
0.859	38.321	0.500	7.950	-2.99E-14	-2.99E-14	8.20E-03	3.01E-02
0.870	38.821	0.548	7.950	2.25E-04	2.25E-04	8.42E-03	3.12E-02
0.888	39.616	0.648	7.950	-2.97E-14	-2.97E-14	8.42E-03	3.12E-02
0.899	40.116	0.500	7.950	4.07E-04	4.07E-04	8.83E-03	3.33E-02
0.910	40.616	0.518	7.950	6.44E-05	6.44E-05	8.89E-03	3.36E-02
0.922	41.151	0.772	7.875	5.71E-05	5.66E-05	8.95E-03	3.39E-02
0.945	42.159	1.043	7.625	-4.20E-13	-4.16E-13	8.95E-03	3.39E-02
0.969	43.236	0.793	7.375	-1.28E-04	-1.27E-04	8.82E-03	3.32E-02
0.980	43.725	0.690	7.250	-8.72E-04	-8.65E-04	7.96E-03	2.85E-02

MAGNUS	FORCE COEFFICIENT	= 7.95915E-03
MAGNUS	MOMENT COEFFICIENT (NOSE)	= 0.028471653
MAGNUS	MOMENT COEFFICIENT (CG)	=-5.49538E-04
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	= 0.049122266
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	=-3.39163E-03
MAGNUS	FORCE COEFFICIENT (NOSE)	= 3.03610E-04
MAGNUS	MOMENT COEFFICIENT (NOSE) (NOSE)	= 8.69618E-04
MAGNUS	MOMENT COEFFICIENT (CG) (NOSE)	= 1.95499E-04
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	= 1.87382E-03
MAGNUS	COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	= 1.20658E-03
MAGNUS	FORCE COEFFICIENT (CYL)	= 8.59094E-03
MAGNUS	MOMENT COEFFICIENT (NOSE) (CYL)	= 0.032757198
MAGNUS	MOMENT COEFFICIENT (CG) (CYL)	=-2.61867E-03
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	0.053021514
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	=-0.016161891
MAGNUS	FORCE COEFFICIENT (BT)	=-9.35395E-04
MAGNUS	MOMENT COEFFICIENT (NOSE) (BT)	=-5.15516E-03
MAGNUS	MOMENT COEFFICIENT (CG) (BT)	= 1.87363E-03
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	=-5.77306E-03
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	= 0.011563677

Figure C-2. Rotating Band Off, $\alpha = 0°$, P = 4900 rpm

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	4	DEG.
SPIN RATE (P):	0	REV/MIN
TIP SPEED RATIO (PD/2V):	0	
X CG/L	0.625112067	

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.0172	0.0168	0.0168	0.0066
0.160	7.139	4.685	3.812	0.0249	0.0246	0.0414	0.0286
0.280	12.492	5.354	5.375	0.0343	0.0339	0.0753	0.0819
0.400	17.846	4.908	6.875	0.0338	0.0335	0.1088	0.1572
0.500	22.308	2.302	7.718	0.0113	0.0113	0.1201	0.1888
0.503	22.449	0.571	7.750	0.0040	0.0040	0.1241	0.2002
0.526	23.450	0.756	7.937	0.0066	0.0066	0.1307	0.2196
0.537	23.961	0.506	7.950	0.0045	0.0045	0.1352	0.2331
0.548	24.461	0.750	7.950	0.0017	0.0017	0.1368	0.2382
0.571	25.461	1.500	7.950	0.0063	0.0063	0.1431	0.2584
0.615	27.461	2.000	7.950	-0.0159	-0.0159	0.1272	0.2035
0.660	29.461	2.000	7.950	-0.0011	-0.0011	0.1262	0.1996
0.705	31.461	2.000	7.950	0.0002	0.0002	0.1264	0.2003
0.750	33.461	3.180	7.950	0.0008	0.0008	0.1271	0.2036
0.848	37.821	2.430	7.950	0.0065	0.0065	0.1337	0.2346
0.859	38.321	0.500	7.950	0.0015	0.0015	0.1352	0.2419
0.870	38.821	0.648	7.950	0.0026	0.0026	0.1378	0.2547
0.888	39.616	0.648	7.950	-0.0042	0.0042	0.1420	0.2755
0.899	40.116	0.500	7.950	0.0049	0.0049	0.1469	0.3004
0.910	40.616	0.518	7.950	0.0057	0.0057	0.1526	0.3293
0.922	41.151	0.772	7.875	-0.0029	-0.0028	0.1497	0.3147
0.945	42.159	1.043	7.625	-0.0057	-0.0056	0.1441	0.2850
0.969	43.236	0.783	7.375	-0.0195	-0.0193	0.1248	0.1799
0.980	43.725	0.690	7.250	-0.0168	-0.0167	0.1031	0.0882

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.160	7.139	4.685	3.812	-6.20E-14	-6.10E-14	-6.10E-14	-5.48E-14
0.280	12.492	5.354	5.375	-1.53E-14	-1.51E-14	-7.61E-14	-7.85E-14
0.400	17.846	4.908	6.875	-1.04E-13	-1.03E-13	-1.79E-13	-3.10E-13
0.500	22.308	2.302	7.718	-7.53E-13	-7.51E-13	-9.30E-13	-2.42E-12
0.503	22.449	0.571	7.750	5.56E-05	5.55E-05	5.55E-05	1.57E-04
0.526	23.450	0.756	7.937	1.08E-04	1.08E-04	1.63E-04	4.75E-04
0.537	23.961	0.506	7.950	-2.79E-05	-2.79E-05	1.36E-04	3.91E-04
0.548	24.461	0.750	7.950	8.24E-05	8.24E-05	2.18E-04	6.45E-04
0.571	25.461	1.500	7.950	-7.55E-05	-7.55E-05	1.43E-04	4.03E-04
0.615	27.461	2.000	7.950	4.78E-04	4.78E-04	6.20E-04	2.05E-03
0.660	29.461	2.000	7.950	-3.30E-04	-3.30E-04	2.90E-04	8.31E-04
0.705	31.461	2.000	7.950	1.78E-04	1.78E-04	4.69E-04	1.54E-03
0.750	33.461	3.180	7.950	2.65E-04	2.65E-04	7.34E-04	2.65E-03
0.848	37.821	2.430	7.950	2.14E-04	2.14E-04	9.48E-04	3.67E-03
0.859	38.321	0.500	7.950	6.38E-06	6.38E-06	9.55E-04	3.70E-03
0.870	38.821	0.648	7.950	-1.05E-05	-1.05E-05	9.44E-04	3.65E-03
0.888	39.616	0.648	7.950	3.32E-05	3.32E-05	9.78E-04	3.82E-03
0.899	40.116	0.500	7.950	3.00E-05	3.00E-05	1.01E-03	3.97E-03
0.910	40.616	0.518	7.950	-4.14E-06	-4.14E-06	1.00E-03	3.95E-03
0.922	41.151	0.772	7.875	1.09E-04	1.08E-04	1.11E-03	4.51E-03
0.945	42.159	1.043	7.625	2.06E-04	2.04E-04	1.32E-03	5.59E-03
0.969	43.236	0.783	7.375	2.37E-04	2.35E-04	1.55E-03	6.86E-03
0.980	43.725	0.690	7.250	2.27E-04	2.25E-04	1.78E-03	8.10E-03

NORMAL FORCE COEFFICIENT = 0.108144826
PITCHING MOMENT COEFFICIENT (NOSE) = 0.088224461
PITCHING MOMENT COEFFICIENT (CG) = 0.291166634
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA = 1.549060534
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA = 4.1?0654823

NORMAL FORCE COEFFICIENT (NOSE) = 0.135161464
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE) = 0.233102629
PITCHING MOMENT COEFFICIENT (CG) (NOSE) = 0.241067589
NORMAL FORCE COEFFICIENT DERIVATIVE WPT ALPHA (NOSE) = 1.936045364
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)= 3.453038863

NORMAL FORCE COEFFICIENT (CYL) = 0.017406246
PITCHING MOMENT COEFFICIENT (NOSE) (CYL) = 0.096240782
PITCHING MOMENT COEFFICIENT (CG) (CYL) =-0.035176606
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL) = 0.249326109
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)=-0.503867761

NORMAL FORCE COEFFICIENT (BT) =-0.044422884
PITCHING MOMENT COEFFICIENT (NOSE) (BT) =-0.241118950
PITCHING MOMENT COEFFICIENT (CG) (BT) = 0.085275651
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT) =-0.636310939
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT) = 1.221483721

MAGNUS FORCE COEFFICIENT = 1.77513E-03
MAGNUS MOMENT COEFFICIENT (NOSE) = 8.10339E-03
MAGNUS MOMENT COEFFICIENT (CG) =-1.87594E-03
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA = 0.025426803
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA =-0.026870880

MAGNUS FORCE COEFFICIENT (NOSE) = 1.35629E-04
MAGNUS MOMENT COEFFICIENT (NOSE) (NOSE) = 3.91289E-04
MAGNUS MOMENT COEFFICIENT (CG) (NOSE) = 8.45194E-05
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE) = 1.94274E-03
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)= 1.21065E-03

MAGNUS FORCE COEFFICIENT (CYL) = 8.67788E-04
MAGNUS MOMENT COEFFICIENT (NOSE) (CYL) = 3.55719E-03
MAGNUS MOMENT COEFFICIENT (CG) (CYL) =-5.12840E-04
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL) = 0.012430145
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)=-7.34589E-03

MAGNUS FORCE COEFFICIENT (BT) = 7.71709E-04
MAGNUS MOMENT COEFFICIENT (NOSE) (BT) = 4.15491E-03
MAGNUS MOMENT COEFFICIENT (CG) (BT) =-1.44762E-03
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT) = 0.011053921
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT) =-0.020735638

Figure C-3. Rotating Band Off, $\alpha = 4°$, $p = 0$ rpm

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	4	DEG.
SPIN RATE (P):	4900	REV/MIN
TIP SPEED RATIO (PD/2V):	0.162027427	
X CG/L	0.625112067	

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.0172	0.0168	0.0168	0.0066
0.160	7.139	4.685	3.812	0.0249	0.0246	0.0414	0.0286
0.280	12.492	5.354	5.375	0.0343	0.0339	0.0753	0.0819
0.400	17.846	4.908	6.875	0.0338	0.0335	0.10[illegible]3	0.1572
0.500	22.308	2.302	7.718	0.0113	0.0113	0.120[illegible]	0.1888
0.503	22.449	0.571	7.750	0.0041	0.0041	0.1242	0.2005
0.526	23.450	0.756	7.937	0.0080	0.0080	0.1322	0.2239
0.537	23.961	0.506	7.950	0.0049	0.0049	0.1371	0.2389
0.548	24.461	0.750	7.950	0.0031	0.0031	0.1403	0.2485
0.571	25.461	1.500	7.950	0.0074	0.0074	0.1477	0.2723
0.615	27.461	2.000	7.950	-0.0041	-0.0041	0.1436	0.2582
0.660	29.461	2.000	7.950	-0.0049	-0.0049	0.1387	0.2401
0.705	31.461	2.000	7.950	0.0015	0.0015	0.1402	0.2460
0.750	33.461	3.180	7.950	-0.0030	-0.0030	0.1372	0.2335
0.848	37.821	2.430	7.950	0.0021	0.0021	0.1393	0.2436
0.859	38.321	0.500	7.950	0.0008	0.0008	0.1401	0.2474
0.870	38.821	0.648	7.950	0.0026	0.0026	0.1427	0.2599
0.888	39.616	0.648	7.950	0.0045	0.0045	0.1472	0.2822
0.899	40.116	0.500	7.950	0.0052	0.0052	0.1524	0.3085
0.910	40.616	0.518	7.950	0.0059	0.0059	0.1583	0.3387
0.922	41.151	0.772	7.875	-0.0015	-0.0015	0.1568	0.3308
0.945	42.159	1.043	7.625	-0.0057	-0.0057	0.1511	0.3007
0.969	43.236	0.783	7.375	-0.0224	-0.0222	0.1289	0.1799
0.980	43.725	0.690	7.250	-0.0179	-0.0178	0.1111	0.0823

ZI/L (IN)	ZI	JZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.160	7.139	4.685	3.812	-[illegible].20E-14	-6.10E-14	-6.10E-14	-5.48E-14
0.280	12.492	5.354	5.375	-1.53E-14	-1.51E-14	-7.61E-14	-7.85E-14
0.400	17.846	4.908	6.875	-1.04E-13	-1.03E-13	-1.79E-13	-3.10E-13
0.500	22.308	2.302	7.718	-7.53E-13	-7.51E-13	-9.30E-13	-2.42E-12
0.503	22.449	0.571	7.750	-5.09E-04	-5.07E-04	-5.07E-04	-1.43E-03
0.526	23.450	0.756	7.937	2.81E-04	2.80E-04	-2.28E-04	-6.08E-04
0.537	23.961	0.506	7.950	1.99E-04	1.99E-04	-2.86E-05	-7.63E-06
0.548	24.461	0.750	7.950	8.23E-04	8.23E-04	7.95E-04	2.53E-03
0.571	25.461	1.500	7.950	6.46E-04	6.46E-04	1.44E-03	4.59E-03
0.615	27.461	2.000	7.950	3.25E-03	3.25E-03	4.69E-03	1.58E-02
0.660	29.461	2.000	7.950	-4.75E-04	-4.75E-04	4.22E-03	1.41E-02
0.705	31.461	2.000	7.950	-5.60E-04	-5.60E-04	3.66E-03	1.18E-02
0.750	33.461	3.180	7.950	4.19E-03	4.19E-03	7.84E-03	2.95E-02
0.848	37.821	2.430	7.950	6.69E-03	6.69E-03	1.45E-02	6.13E-02
0.859	38.321	0.500	7.950	-9.37E-04	-9.37E-04	1.36E-02	5.68E-02
0.870	38.821	0.648	7.950	6.57E-04	6.57E-04	1.43E-02	6.00E-02
0.888	39.616	0.648	7.950	6.41E-04	6.41E-04	1.49E-02	6.32E-02
0.899	40.116	0.500	7.950	-4.56E-04	-4.56E-04	1.44E-02	6.09E-02
0.910	40.616	0.518	7.950	-6.84E-04	-6.64E-04	1.38E-02	5.74E-02
0.922	41.151	0.772	7.875	6.56E-04	6.50E-04	1.44E-02	6.08E-02
0.945	42.159	1.043	7.625	2.19E-03	2.17E-03	1.66E-02	7.23E-02
0.969	43.236	0.78[illegible]	7.375	9.24E-04	9.16E-04	1.75E-02	7.73E-02
0.980	43.725	0.690	7.250	-6.95E-04	-6.89E-04	1.68E-02	7.35E-02

NORMAL	FORCE COEFFICIENT	= 0.111129363
PITCHING	MOMENT COEFFICIENT (NOSE)	= 0.082261604
PITCHING	MOMENT COEFFICIENT (CG)	= 0.307599773
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA	= 1.591810874
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA	= 4.406042188
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	= 0.685867603
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	= 1.898442612
NORMAL	FORCE COEFFICIENT (NOSE)	= 0.137107864
PITCHING	MOMENT COEFFICIENT (NOSE) (NOSE)	= 0.238861549
PITCHING	MOMENT COEFFICIENT (CG) (NOSE)	= 0.242136983
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)	= 1.963925487
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)	= 3.468356792
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	= 0.846201573
MOMENT	COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	= 1.494419719
NORMAL	FORCE COEFFICIENT (CYL)	= 0.021182364
PITCHING	MOMENT COEFFICIENT (NOSE) (CYL)	= 0.099805589
PITCHING	MOMENT COEFFICIENT (CG) (CYL)	=-0.025498[illegible]
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)	= 0.303415014
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)	=-0.365233746
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	= 0.130733199
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	=-0.157369194
NORMAL	FORCE COEFFICIENT (BT)	=-0.047160865
PITCHING	MOMENT COEFFICIENT (NOSE) (BT)	=-0.256409534
PITCHING	MOMENT COEFFICIENT (CG) (BT)	= 0.090960916
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)	=-0.67552[illegible]
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)	= 1.302919142
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	=-0.291067170
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	= 0.561392087

MAGNUS	FORCE COEFFICIENT	= 0.016806859
MAGNUS	MOMENT COEFFICIENT (NOSE)	= 0.073477580
MAGNUS	MOMENT COEFFICIENT (CG)	=-0.014516158
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA	= 0.240740528
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA	=-0.207928647
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	= 0.103728484
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	=-0.089590745
MAGNUS	FORCE COEFFICIENT (NOSE)	=-2.85802E-05
MAGNUS	MOMENT COEFFICIENT (NOSE) (NOSE)	=-7.62698E-06
MAGNUS	MOMENT COEFFICIENT (CG) (NOSE)	=-9.26375E-05
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)	=-4.09382E-04
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)	=-1.[illegible]2693E-03
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	=-1.75391E-04
MAGNUS	COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	=-5.71740E-04
MAGNUS	FORCE COEFFICIENT (CYL)	= 0.013785181
MAGNUS	MOMENT COEFFICIENT (NOSE) (CYL)	= 0.057403681
MAGNUS	MOMENT COEFFICIENT (CG) (CYL)	=-9.04284E-03
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)	= 0.197458176
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALP - (CYL)	=-0.129529109
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	= 0.035079307
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	=-0.055810537
MAGNUS	FORCE COEFFICIENT (BT)	= 3.05026E-03
MAGNUS	MOMENT COEFFICIENT (NOSE) (BT)	= 0.016081526
MAGNUS	MOMENT COEFFICIENT (CG) (BT)	=-5.38068E-03
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)	= 0.043691733
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)	=-0.077072603
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	= 0.018825568
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	=-0.033208469

Figure C-4. Rotating Band Off, $\alpha = 4°$, P = 4900 rpm

REF. LENGTH (L): 44.616 IN.
REF. DIAMETER (D): 7.95 IN.
ROTATING BAND: OFF
MACH NO.: 0.94
ANGLE OF ATTACK (ALPHA): 10 DEG.
SPIN RATE (P): 0 REV/MIN
TIP SPEED RATIO (PD/2V): 0
X CG/L 0.625112067

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.0442	0.0432	0.0432	0.0170
0.160	7.139	4.685	3.812	0.0652	0.0642	0.1074	0.0746
0.280	12.492	5.354	5.375	0.0830	0.0820	0.1894	0.2035
0.400	17.846	4.908	6.875	0.0801	0.0795	0.2689	0.3819
0.500	22.308	2.302	7.718	0.0328	0.0327	0.3016	0.4736
0.503	22.449	0.571	7.750	0.0108	0.0107	0.3123	0.5038
0.526	23.450	0.756	7.937	0.0151	0.0150	0.3273	0.5482
0.537	23.961	0.506	7.950	0.0096	0.0096	0.3369	0.5772
0.548	24.461	0.750	7.950	0.0072	0.0072	0.3442	0.5994
0.571	25.461	1.500	7.950	0.0296	0.0296	0.3738	0.6943
0.615	27.461	2.000	7.950	-0.0243	-0.0243	0.3496	0.6106
0.660	29.461	2.000	7.950	-0.0084	-0.0084	0.3412	0.5795
0.705	31.461	2.000	7.950	-0.0004	-0.0004	0.3408	0.5781
0.750	33.461	3.180	7.950	0.0017	0.0017	0.3425	0.5852
0.848	37.821	2.430	7.950	0.0161	0.0161	0.3586	0.6619
0.859	38.321	0.500	7.950	0.0038	0.0038	0.3624	0.6801
0.870	38.821	0.648	7.950	0.0062	0.0062	0.3686	0.7104
0.888	39.616	0.648	7.950	0.0085	0.0085	0.3771	0.7525
0.899	40.116	0.500	7.950	0.0088	0.0088	0.3859	0.7972
0.910	40.616	0.518	7.950	0.0085	0.0085	0.3944	0.8406
0.922	41.151	0.772	7.875	-0.0013	-0.0013	0.3931	0.8338
0.945	42.159	1.043	7.625	-0.0084	-0.0083	0.3848	0.7898
0.969	43.236	0.783	7.375	-0.0267	-0.0265	0.3583	0.6459
0.980	43.725	0.690	7.250	-0.0277	-0.0274	0.3309	0.4950

NORMAL FORCE COEFFICIENT = 0.330908777
PITCHING MOMENT COEFFICIENT (NOSE) = 0.495022242
PITCHING MOMENT COEFFICIENT (CG) = 0.665864019
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA = 1.895967630
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA = 3.815119802

NORMAL FORCE COEFFICIENT (NOSE) = 0.336940447
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE) = 0.577170154
PITCHING MOMENT COEFFICIENT (CG) (NOSE) = 0.604876269
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE) = 1.930526555
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)= 3.465685735

NORMAL FORCE COEFFICIENT (CYL) = 0.057473186
PITCHING MOMENT COEFFICIENT (NOSE) (CYL) = 0.263440835
PITCHING MOMENT COEFFICIENT (CG) (CYL) =-0.061814779
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL) = 0.329297097
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)=-0.354172595

NORMAL FORCE COEFFICIENT (BT) =-0.063504856
PITCHING MOMENT COEFFICIENT (NOSE) (BT) =-0.345588747
PITCHING MOMENT COEFFICIENT (CG) (BT) = 0.122802529
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT) =-0.363856022
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT) = 0.703606663

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	8.40E-15	8.21E-15	8.21E-15	3.23E-15
0.160	7.139	4.685	3.812	-1.17E-13	-1.15E-13	-1.07E-13	-1.00E-13
0.280	12.492	5.354	5.375	-3.11E-13	-3.07E-13	-4.14E-13	-5.82E-13
0.400	17.846	4.908	6.875	-1.66E-13	-1.65E-13	-5.79E-13	-9.53E-13
0.500	22.308	2.302	7.718	8.90E-13	8.87E-13	3.08E-13	1.54E-12
0.503	22.449	0.571	7.750	1.37E-05	1.37E-05	1.37E-05	3.87E-05
0.526	23.450	0.756	7.937	-1.23E-13	-1.23E-13	1.37E-05	3.87E-05
0.537	23.961	0.506	7.950	-1.35E-13	-1.35E-13	1.37E-05	3.87E-05
0.548	24.461	0.750	7.950	-9.07E-14	-9.07E-14	1.37E-05	3.87E-05
0.571	25.461	1.500	7.950	1.60E-05	1.60E-05	2.97E-05	9.99E-05
0.615	27.461	2.000	7.950	-1.39E-14	-1.39E-14	2.97E-05	8.99E-05
0.660	29.461	2.000	7.950	-2.34E-14	-2.34E-14	2.97E-05	8.99E-05
0.705	31.461	2.000	7.950	-8.90E-15	-8.90E-15	2.97E-05	8.99E-05
0.750	33.461	3.180	7.950	-8.62E-14	-8.62E-14	2.97E-05	8.99E-05
0.848	37.821	2.430	7.950	5.95E-15	5.95E-15	2.97E-05	8.99E-05
0.859	38.321	0.500	7.950	9.59E-15	9.59E-15	2.97E-05	8.99E-05
0.870	38.821	0.648	7.950	-4.71E-14	-4.71E-14	2.97E-05	8.99E-05
0.888	39.616	0.648	7.950	-4.05E-14	-4.05E-14	2.97E-05	8.99E-05
0.899	40.116	0.500	7.950	-5.01E-14	-5.01E-14	2.97E-05	8.99E-05
0.910	40.616	0.518	7.950	-3.09E-13	-3.09E-13	2.97E-05	8.99E-05
0.922	41.151	0.772	7.875	-2.47E-13	-2.44E-13	2.97E-05	8.99E-05
0.945	42.159	1.043	7.625	-4.50E-13	-4.47E-13	2.97E-05	8.99E-05
0.969	43.236	0.783	7.375	1.67E-13	1.65E-13	2.97E-05	8.99E-05
0.980	43.725	0.690	7.250	-4.46E-14	-4.42E-14	2.97E-05	8.99E-05

MAGNUS FORCE COEFFICIENT = 2.96846E-05
MAGNUS MOMENT COEFFICIENT (NOSE) = 8.98762E-05
MAGNUS MOMENT COEFFICIENT (CG) = 1.42626E-05
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA = 1.70080E-04
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA = 8.17185E-05

MAGNUS FORCE COEFFICIENT (NOSE) = 1.37064E-05
MAGNUS MOMENT COEFFICIENT (NOSE) (NOSE) = 3.87037E-05
MAGNUS MOMENT COEFFICIENT (CG) (NOSE) = 9.38067E-06
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE) = 7.85317E-05
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)= 5.37473E-05

MAGNUS FORCE COEFFICIENT (CYL) = 1.59782E-05
MAGNUS MOMENT COEFFICIENT (NOSE) (CYL) = 5.11725E-05
MAGNUS MOMENT COEFFICIENT (CG) (CYL) = 4.88190E-06
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL) = 9.15485E-05
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)= 2.79712E-05

MAGNUS FORCE COEFFICIENT (BT) =-5.69900E-13
MAGNUS MOMENT COEFFICIENT (NOSE) (BT) =-2.97770E-12
MAGNUS MOMENT COEFFICIENT (CG) (BT) = 9.78390E-13
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT) =-3.26529E-12
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT) = 5.60576E-12

Figure C-5. Rotating Band Off, $\alpha = 10°$, P = 0 rpm

REF. LENGTH (L):	44.616	IN.
REF. DIAMETER (D):	7.95	IN.
ROTATING BAND:	OFF	
MACH NO.:	0.94	
ANGLE OF ATTACK (ALPHA):	10	DEG.
SPIN RATE (P):	-4900	REV/MIN
TIP SPEED RATIO (PD/2V):	-0.162027427	
X CG/L	0.625112067	

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.0442	0.0432	0.0432	0.0170
0.160	7.139	4.685	3.812	0.0652	0.0642	0.1074	0.0746
0.280	12.492	5.354	5.375	0.0830	0.0820	0.1894	0.2035
0.400	17.846	4.908	6.875	0.0801	0.0795	0.2689	0.3819
0.500	22.308	2.302	7.718	0.0328	0.0327	0.3016	0.4736
0.503	22.449	0.571	7.750	0.0109	0.0109	0.3125	0.5043
0.526	23.450	0.756	7.937	0.0165	0.0165	0.3290	0.5530
0.537	23.961	0.506	7.950	0.0106	0.0106	0.3395	0.5848
0.548	24.461	0.750	7.950	0.0148	0.0148	0.3543	0.6304
0.571	25.461	1.500	7.950	0.0255	0.0255	0.3798	0.7120
0.615	27.461	2.000	7.950	0.0132	0.0132	0.3931	0.7578
0.660	29.461	2.000	7.950	-0.0078	-0.0078	0.3853	0.7289
0.705	31.461	2.000	7.950	0.0012	0.0012	0.3865	0.7338
0.750	33.461	3.180	7.950	0.0036	0.0036	0.3901	0.7487
0.848	37.821	2.430	7.950	0.0172	0.0172	0.4073	0.8306
0.859	38.321	0.500	7.950	0.0021	0.0021	0.4094	0.8408
0.870	38.821	0.648	7.950	0.0070	0.0070	0.4164	0.8750
0.888	39.616	0.648	7.950	0.0084	0.0084	0.4248	0.9171
0.899	40.116	0.500	7.950	0.0095	0.0095	0.4344	0.9652
0.910	40.616	0.518	7.950	0.0099	0.0099	0.4442	1.0156
0.922	41.151	0.772	7.875	0.0006	0.0005	0.4448	1.0184
0.945	42.159	1.043	7.625	-0.0071	-0.0070	0.4378	0.9812
0.969	43.236	0.783	7.375	-0.0224	-0.0222	0.4156	0.8606
0.980	43.725	0.690	7.250	-0.0251	-0.0248	0.3907	0.7240

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	8.40E-15	8.21E-15	9.21E-15	3.23E-15
0.160	7.139	4.685	3.812	-1.17E-13	-1.15E-13	-1.07E-13	-1.00E-13
9.280	12.492	5.354	5.375	-3.11E-13	-3.07E-13	-4.14E-13	-5.82E-13
0.400	17.846	4.908	6.875	-1.66E-13	-1.65E-13	-5.79E-13	-9.53E-13
0.500	22.308	2.302	7.718	8.90E-13	8.87E-13	3.08E-13	1.54E-12
0.503	22.449	0.571	7.750	5.89E-04	5.87E-04	5.87E-04	1.66E-03
0.526	23.450	0.756	7.937	1.03E-04	.03E-04	6.90E-04	1.96E-03
0.537	23.961	0.506	7.950	-3.14E-05	-3.14E-05	6.58E-04	1.87E-03
0.548	24.461	0.750	7.950	-1.72E-03	-1.72E-03	-1.06E-03	-3.42E-03
0.571	25.461	1.500	7.950	3.12E-03	3.12E-03	2.06E-03	6.57E-03
0.615	27.461	2.000	7.950	2.70E-03	2.70E-03	4.76E-03	1.59E-02
0.660	29.461	2.000	7.950	1.28E-03	1.28E-03	6.04E-03	2.06E-02
0.705	31.461	2.000	7.950	6.40E-04	6.46E-04	6.68E-03	2.32E-02
0.750	33.461	3.180	7.950	2.04E-03	2.04E-03	8.71E-03	3.17E-02
0.848	37.821	2.430	7.950	5.88E-03	5.88E-03	1.46E-02	5.97E-02
0.859	38.321	0.500	7.950	5.24E-04	5.24E-04	1.51E-02	6.22E-02
0.870	38.821	0.648	7.950	7.60E-04	7.60E-04	1.59E-02	6.59E-02
0.888	39.616	0.648	7.950	8.01E-04	8.01E-04	1.67E 02	6.99E-02
0.899	40.116	0.500	7.950	-2.16E-04	-2.16E-04	1.65E-02	6.88E-02
0.910	40.616	0.518	7.950	-8.53E-04	-8.53E-04	1.56E-02	6.45E-02
0.922	41.151	0.772	7.875	2.07E-03	2.05E-03	1.77E-02	7.51E-02
0.945	42.159	1.043	7.625	4.00E-03	3.97E-03	2.16E-02	9.62E-02
0.969	43.236	0.783	7.375	5.13E-03	5.09E-03	2.67E-02	1.24E-01
0.980	43.725	0.690	7.250	1.79E-03	1.77E-03	2.85E-02	1.34E-01

NORMAL FORCE COEFFICIENT	= 0.390741688
PITCHING MOMENT COEFFICIENT (NOSE)	= 0.723960603
PITCHING MOMENT COEFFICIENT (CG)	= 0.646830047
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA	= 2.238784958
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA	= 3.706063176
NORMAL FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	= 2.411577432
MOMENT COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	= 3.992102184
NORMAL FORCE COEFFICIENT (NOSE)	= 0.339523795
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE)	= 0.584828384
PITCHING MOMENT COEFFICIENT (CG) (NOSE)	= 0.606280880
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)	= 1.94532805
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)	= 3.473733560
NORMAL FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	= 2.095471121
MOMENT COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	= 3.74184105
NORMAL FORCE COEFFICIENT (CYL)	= 0.104702921
PITCHING MOMENT COEFFICIENT (NOSE) (CYL)	= 0.430730194
PITCHING MOMENT COEFFICIENT (CG) (CYL)	=-0.063413910
NORMAL FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)	= 0.599903545
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)	=-0.36333494
NORMAL FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	= 0.646204919
MOMENT COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	=-0.391377626
NORMAL FORCE COEFFICIENT (BT)	=-0.053485028
PITCHING MOMENT COEFFICIENT (NOSE) (BT)	=-0.291597975
PITCHING MOMENT COEFFICIENT (CG) (BT)	= 0.103963078
NORMAL FORCE COEFFICIEN DERIVATIVE WRT ALPHA (BT)	=-0.306446638
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)	= 0.595664557
NORMAL FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	=-0.330098607
MOMENT COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	= 0.641638759

MAGNUS FORCE COEFFICIENT	= 0.028490529
MAGNUS MOMENT COEFFICIENT (NOSE)	= 0.133576758
MAGNUS MOMENT COEFFICIENT (CG)	=-0.033626963
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA	= 0.163238709
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WPT ALFHA	=-0.192666307
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	= 0.175837695
MAGNUS COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	=-0.207538710
MAGNUS FORCE COEFFICIENT (NOSE)	= 6.58461E-04
MAGNUS MOMENT COEFFICIENT (NOSE) (NOSE)	= 1.86630E-03
MAGNUS MOMENT COEFFICIENT (CG) (NOSE)	= 4.43699E-04
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)	= 3.77270E-03
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)	= 2.54221E-03
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	= 4.06389E-03
MAGNUS COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	= 2.73842E-03
MAGNUS FORCE COEFFICIENT (CYL)	= 0.014948647
MAGNUS MOMENT COEFFICIENT (NOSE) (CYL)	= 0.062611478
MAGNUS MOMENT COEFFICIENT (CG) (CYL)	=-0.010168994
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)	= 0.085649436
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)	=-0.058264042
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	= 0.092259976
MAGNUS COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	=-0.062760940
MAGNUS FORCE COEFFICIENT (BT)	= 0.012883422
MAGNUS MOMENT COEFFICIENT (NOSE) (BT)	= 0.069098981
MAGNUS MOMENT COEFFICIENT (CG) (BT)	=-0.023901668
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)	= 0.073816569
MAGNUS MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)	=-0.136946472
MAGNUS FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	= 0.079513832
MAGNUS COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	=-0.147516188

Figure C-6. Rotating Band Off, $\alpha = 10°$, P = 4900 rpm

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REF. LENGTH (L):                     44.616   IN.
REF. DIAMETER (D):                   7.95     IN.
ROTATING BAND:                       ON
MACH NO.:                            0.94
ANGLE OF ATTACK (ALPHA):             0        DEG.
SPIN RATE (P):                       0        REV/MIN
TIP SPEED RATIO (PD/2V):             0
X CG/L                               0.625112067
```

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	-0.0003	-0.0003	-0.0003	-0.0001
0.160	7.139	4.685	3.812	-0.0004	-0.0004	-0.0007	-0.0005
0.280	12.492	5.354	5.375	-0.0006	-0.0005	-0.0013	-0.0014
0.400	17.846	4.908	6.875	-0.0007	-0.0006	-0.0019	-0.0025
0.500	22.308	2.302	7.718	0.0001	0.0001	-0.0018	-0.0024
0.503	22.449	0.571	7.750	0.0000	0.0000	-0.0018	-0.0024
0.526	23.450	0.756	7.937	0.0000	0.0000	-0.0018	-0.0024
0.537	23.961	0.506	7.950	0.0000	0.0000	-0.0018	-0.0024
0.548	24.461	0.750	7.950	0.0000	0.0000	-0.0018	-0.0024
0.571	25.461	1.500	7.950	0.0000	0.0000	-0.0018	-0.0024
0.615	27.461	2.000	7.950	0.0000	0.0000	-0.0018	-0.0024
0.660	29.461	2.000	7.950	0.0000	0.0000	-0.0018	-0.0024
0.705	31.461	2.000	7.950	0.0000	0.0000	-0.0019	-0.0024
0.750	33.461	3.180	7.950	-0.0003	-0.0003	-0.0021	-0.0038
0.848	37.821	2.430	7.950	-0.0005	-0.0005	-0.0026	-0.0062
0.859	38.321	0.500	7.950	-0.0001	-0.0001	-0.0027	-0.0064
0.870	38.821	0.648	7.950	0.0002	0.0002	-0.0025	-0.0055
0.888	39.616	0.648	7.950	0.0000	0.0000	-0.0025	-0.0055
0.899	40.116	0.500	7.950	0.0000	0.0000	-0.0025	-0.0055
0.910	40.616	0.519	7.950	0.0000	0.0000	-0.0025	-0.0054
0.922	41.151	0.772	7.875	-0.0002	-0.0002	-0.0027	-0.0065
0.945	42.159	1.043	7.625	-0.0002	-0.0002	-0.0029	-0.0078
0.969	43.236	0.783	7.375	-0.0005	-0.0005	-0.0034	-0.0102
0.980	43.725	0.690	7.250	-0.0003	-0.0003	-0.0037	-0.0120

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.160	7.139	4.685	3.812	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.280	12.492	5.354	5.375	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.400	17.846	4.908	6.875	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.500	22.306	2.302	7.718	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.503	22.449	0.571	7.750	4.33E-14	4.32E-14	4.32E-14	1.22E-13
0.526	23.450	0.756	7.937	-1.09E-13	1.09E-13	-6.56E-14	-1.99E-13
0.537	23.961	0.506	7.950	-2.04E-13	-2.04E-13	-2.69E-13	-8.13E-13
0.548	24.461	0.750	7.950	-4.17E-14	-4.17E-14	-3.11E-13	-9.42E-13
0.571	25.461	1.500	7.950	-1.40E-13	-1.40E-13	-4.51E-13	-1.39E-12
0.613	27.461	2.000	7.950	-3.34E-14	-3.34E-14	-4.84E-13	-1.50E-12
0.660	29.461	2.000	7.950	-2.64E-14	-2.64E-14	-5.11E-13	-1.60E-12
0.705	31.461	2.000	7.950	-1.08E-14	-1.08E-14	-5.22E-13	-1.65E-12
0.750	33.461	3.180	7.950	2.84E-05	2.84E-05	2.84E-05	1.20E-04
0.848	37.821	2. [illegible]0	7.950	-1.40E-03	-1.40E-03	-1.37E-03	-6.52E-03
0.859	38.321	0.500	7.950	-3.51E-05	-3.51E-05	-1.40E-03	-6.69E-03
0.870	38.821	0.648	7.950	2.47E-05	2.47E-05	-1.38E-03	-6.57E-03
0.888	39.616	0.648	7.950	-1.02E-13	-1.02E-13	.38E-03	-6.57E-03
0.899	40.116	0.500	7.950	6.88E-05	6.88E-05	.31E-03	-6.22E-03
0.910	40.616	0.518	7.950	7.31E-06	7.31E-06	-1.30E-03	-6.18E-03
6.922	41.151	0.772	7.875	2.34E-05	2.32E-05	-1.28E-03	-6.06E-03
0.945	42.159	1.043	7.625	-8.51E-04	-8.44E-04	-2.12E-03	-1.05E-02
0.969	43.236	0.783	7.375	-5.66E-04	-5.61E-04	-2.68E-03	-1.36E-02
0.9[illegible]	43.725	0.690	7.250	-3.09E-04	-3.07E-04	-2.99E-03	-1.53E-02

```
NORMAL   FORCE COEFFICIENT                          =-3.69493E-03
PITCHING MOMENT COEFFICIENT (NOSE)                  =-0.012041447
PITCHING MOMENT COEFFICIENT (CG)                    =-9.21000E-04

NORMAL   FORCE COEFFICIENT (NOSE)                   =-1.79196E-03
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE)           =-2.42109E-03
PITCHING MOMENT COEFFICIENT (CG) (NOSE)             =-3.86544E-03

NORMAL   FORCE COEFFICIENT (CYL)                    =-6.65797E-04
PITCHING MOMENT COEFFICIENT (NOSE) (CYL)            =-2.95985E-03
PITCHING MOMENT COEFFICIENT (CG) (CYL)              = 6.24115E-04

NORMAL   FORCE COEFFICIENT (BT)                     =-1.23716E-03
PITCHING MOMENT COEFFICIENT (NOSE) (BT)             =-6.66051E-33
PITCHING MOMENT COEFFICIENT (CG) (BT)               = 2.32032E-03

MAGNUS   FORCE COEFFICIENT                          =-2.98886E-03
MAGNUS   MOMENT COEFFICIENT (NOSE)                  =-0.015271450
MAGNUS   MOMENT COEFFICIENT (CG)                    = 4.78601E-03

MAGNUS   FORCE COEFFICIENT (NOSE)                   =-2.69449E-13
MAGNUS   MOMENT COEFFICIENT (NOSE) (NOSE)           =-8.13333E-13
MAGNUS   MOMENT COEFFICIENT (CG) (NOSE)             =-1.31941E-13

MAGNUS   FORCE COEFFICIENT (CYL)                    =-1.33127E-03
MAGNUS   MOMENT COEFFICIENT (NOSE) (CYL)            =-6.18284E-03
MAGNUS   MOMENT COEFFICIENT (CG) (CYL)              = 1.61777E-03

MAGNUS   FORCE COEFFICIENT (BT)                     =-1.68759E-03
MAGNUS   MOMENT COEFFICIENT (NOSE) (BT)             =-9.08861E-03
MAGNUS   MOMENT COEFFICIENT (CG) (BT)               = 3.16824E-03
```

Figure C-7. Rotating Band On, $\alpha = 0°$, $P = 0$ rpm

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	ON
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	0 DEG.
SPIN RATE (P):	4900 REV/MIN
TIP SPEED RATIO (PD/2V):	0.162077427
X CG/L	0.625112067

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	-0.0003	-0.0003	-0.0003	-0.0001
0.160	7.139	4.685	3.812	-0.0004	-0.0004	-0.0007	-0.0005
0.280	12.492	5.354	5.375	-0.0006	-0.0005	-0.0013	-0.0014
0.400	17.846	4.908	6.675	-0.0007	-0.0006	-0.0019	-0.0028
0.500	22.308	2.302	7.718	0.0001	0.0001	-0.0018	-0.0024
0.503	22.449	0.571	7.750	0.0004	0.0004	-0.0014	-0.0013
0.526	23.450	0.756	7.937	0.0000	0.0000	-0.0014	-0.0013
0.537	23.961	0.506	7.950	0.0000	0.0000	-0.0014	-0.0013
0.548	24.461	0.750	7.950	-0.0003	-0.0003	-0.0017	-0.0022
0.571	25.461	1.500	7.950	0.0007	0.0007	-0.0009	0.0002
0.615	27.461	2.000	7.950	-0.0013	-0.0013	-0.0022	-0.0043
0.660	29.461	2.000	7.950	0.0000	0.0000	-0.0022	-0.0043
0.705	31.461	2.000	7.950	-0.0012	-0.0012	-0.0034	-0.0088
0.750	33.461	3.180	7.950	-0.0009	-0.0009	-0.0043	-0.0128
0.848	37.821	2.430	7.950	0.0006	0.0006	-0.0038	-0.0102
0.859	38.321	0.500	7.950	0.0000	0.0000	-0.0037	-0.0100
0.870	38.821	0.648	7.950	0.0016	-0.0016	-0.0053	-0.0178
0.888	39.616	0.648	7.950	-0.0014	-0.0014	-0.0067	-0.0245
0.899	40.116	0.500	7.950	0.0002	0.0002	-0.0065	-0.0235
0.910	40.616	0.518	7.950	0.0023	0.0023	-0.0041	-0.0115
0.922	41.151	0.772	7.875	-0.0008	-0.0008	-0.0049	-0.0154
0.945	42.159	1.043	7.625	-0.0065	-0.0065	-0.0114	-0.0497
0.965	43.236	0.783	7.375	-0.0027	-0.0026	-0.0140	-0.0641
0.980	43.725	0.690	7.250	-0.0014	-0.0014	-0.0154	-0.0717

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.160	7.139	4.685	3.812	0 00E+00	0.00E+00	0.00E+00	0.00E+00
0.280	12.492	5.354	5.375	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.400	17.846	4.908	6.875	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.500	22.308	2.302	7.718	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.503	22.449	0.571	7.750	2.40E-04	2.39E-04	2.39E-04	6.75E-04
0.526	23.450	0.756	7.937	-1.09E-13	-1.09E-13	2.39E-04	6.75E-04
0.537	23.961	0.506	7.950	6.46E-05	6.46E-05	3.04E-04	8.70E-04
0.548	24.461	0.750	7.950	4.15E-04	4.15E-04	7.18E-04	2.15E-03
0.571	25.461	1.500	7.950	-5.11E-04	-5.11E-04	2.07E-04	5.08E-04
0.615	27.461	2.000	7.950	4.75E-03	4.75E-03	4.96E-03	1.69E-02
0.660	29.461	2.000	7.950	-2.14E-14	-2.14E-14	4.96E-03	1.69E-02
0.705	31.461	2.000	7.950	1.63E-03	1.63E-03	6.59E-03	2.34E-02
0.750	33.461	3.180	7.950	-1.06E-03	-1.06E-03	5.54E-03	1.89E-02
0.848	37.821	2.430	7.950	2.08E-03	2.08E-03	7.61E-03	2.88E-02
0.859	38.321	0.500	7.950	3.70E-04	3.70E-04	7.98E-03	3.06E-02
0.870	38.821	0.648	7.950	-1.22E-02	-1.22E-02	-4.22E-03	-2.90E-02
0.688	39.616	0.648	7.950	1.59E-04	1.59E-04	-4.06E-03	-2.82E-02
0.899	40.116	0.500	7.950	2.14E-04	2.14E-04	-3.84E-03	-2.71E-02
0.910	40.616	0.518	7.950	-1.02E-05	-1.02E-05	-3.85E-03	-2.72E-02
0.922	41.151	0.772	7.875	1.08E-03	1.07E-03	-2.78E-03	-2.16E-02
0.945	42.159	1.043	7.625	-6.60E-03	-6.54E-03	-9.32E-03	-5.63E-02
0.969	43.236	0.783	7.375	-1.60E-04	-1.58E-04	-9.48E-03	-5.72E-02
0.980	43.725	0.690	7.250	4.02E-04	3.99E-04	-9.08E-03	-5.50E-02

NORMAL	FORCE COEFFICIENT	=-0.015396297
PITCHING	MOMENT COEFFICIENT (NOSE)	=-0.071743343
PITCHING	MOMENT COEFFICIENT (CG)	= 0.017730420
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	=-0.095022785
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	= 0.109428513
NORMAL	FORCE COEFFICIENT (NOSE)	=-1.39728E-03
PITCHING	MOMENT COEFFICIENT (NOSE) (NOSE)	=-1.30473E-03
PITCHING	MOMENT COEFFICIENT (CG) (NOSE)	=-3.59718E-03
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	=-8.62373E-03
MOMENT	COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	=-0.022201040
NORMAL	FORCE COEFFICIENT (CYL)	=-2.74660E-03
PITCHING	MOMENT COEFFICIENT (NOSE) (CYL)	=-0.010231059
PITCHING	MOMENT COEFFICIENT (CG) (CYL)	= 5.95503E-04
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	=-0.016951441
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	= 3.67536E-03
NORMAL	FORCE COEFFICIENT (BT)	=-0.011252417
PITCHING	MOMENT COEFFICIENT (NOSE) (BT)	=-0.060207551
PITCHING	MOMENT COEFFICIENT (CG) (BT)	= 0.020732089
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	=-0.069447609
MOMENT	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	= 0.127954196

MAGNUS	FORCE COEFFICIENT	=-9.08419E-03
MAGNUS	MOMENT COEFFICIENT (NOSE)	=-0.054962106
MAGNUS	MOMENT COEFFICIENT (CG)	= 0.023093162
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE	=-0.056065765
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE	= 0.142526254
MAGNUS	FORCE COEFFICIENT (NOSE)	= 3.03610E-04
MAGNUS	MOMENT COEFFICIENT (NOSE) (NOSE)	= 8.69618E-04
MAGNUS	MOMENT COEFFICIENT (CG) (NOSE)	= 1.55499E-04
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)	= 1.87382E-03
MAGNUS	COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)	= 1.20658E-03
MAGNUS	FORCE COEFFICIENT (CYL)	=-4.15853E-03
MAGNUS	MOMENT COEFFICIENT (NOSE) (CYL)	=-0.028021873
MAGNUS	MOMENT COEFFICIENT (CG) (CYL)	= 0.013433025
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)	=-0.025665581
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)	= 0.082905870
MAGNUS	FORCE COEFFICIENT (BT)	=-5.22927E-03
MAGNUS	MOMENT COEFFICIENT (NOSE) (BT)	=-0.027809851
MAGNUS	MOMENT COEFFICIENT (CG) (BT)	= 9.46464E-03
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)	=-0.032274001
MAGNUS	COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)	= 0.058413805

Figure C-8. Rotating Band On, $\alpha = 0°$, P = 4900 rpm

REF. LENGTH (L):	44.616 IN.
REF. DIAMETER (D):	7.95 IN.
ROTATING BAND:	ON
MACH NO.:	0.94
ANGLE OF ATTACK (ALPHA):	10 DEG.
SPIN RATE (P):	0 REV/MIN
TIP SPEED RATIO (PD/2V):	0
X CG/L	0.625112067

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	LM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.0442	0.0432	0.0432	0.0.70
0.160	7.139	4.685	3.812	0.0652	0.0642	0.1074	0.0746
0.280	12.492	5.354	5.375	0.0830	0.0820	0.1894	0.2035
0.400	17.846	4.908	6.875	0.0801	0.0795	0.2689	0.3819
0.500	22.308	2.302	7.718	0.0328	0.0327	0.3016	0.4736
0.503	22.449	0.571	7.750	0.0108	0.0107	0.3123	0.5038
0.526	23.450	0.756	7.937	0.0151	0.0150	0.3273	0.5482
0.537	23.961	0.506	7.950	0.0096	0.0096	0.3369	0.5772
0.548	24.461	0.750	7.950	0.0072	0.0072	0.3442	0.5994
0.571	25.461	1.500	7.950	0.0296	0.0296	0.3738	0.6943
0.615	27.461	2.000	7.950	-0.0243	-0.0243	0.3496	0.6106
0.660	29.461	2.000	7.950	-0.0084	-0.0084	0.3412	0.5795
0.705	31.461	2.000	7.950	-0.0004	-0.0004	0.3408	0.5781
0.750	33.461	3.180	7.950	0.0060	0.0060	0.3468	0.6032
0.848	37.821	2.430	7.950	-0.0143	-0.0143	0.3325	0.5357
0.859	38.321	0.500	7.950	0.0076	0.0076	0.3401	0.5719
0.870	38.821	0.648	7.950	0.0140	0.0140	0.3541	0.6404
0.888	39.616	0.648	7.950	0.0075	0.0075	0.3616	0.6777
0.899	40.116	0.500	7.950	0.0098	0.0098	0.3714	0.7273
0.910	40.616	0.518	7.950	0.0055	0.0055	0.3769	0.755_
0.922	41.151	0.772	7.875	-0.0038	-0.0038	0.3731	0.7355
0.945	42.159	1.043	7.625	-0.0347	-0.0344	0.3387	0.5530
0.969	43.236	0.783	7.375	-0.0347	-0.0344	0.3043	0.3661
0.980	43.725	0.690	7.250	-0.0311	-0.0338	0.2735	0.1965

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	8.40E-15	8.21E-15	8.21E-15	3.23E-15
0.160	7.139	4.685	3.812	-1.17E-13	-1.15E-13	-1.07E-13	-1.00E-13
0.280	12.492	5.354	5.375	-3.11E-13	-3.07E-13	-4.14E-13	-5.82E-13
0.400	17.846	4.908	6.875	-1.66E-13	-1.65E-13	-5.79E-13	-9.53E-13
0.500	22.308	2.302	7.718	8.90E-13	8.87E-13	3.08E-13	1.54E-13
0.503	22.449	0.571	7.750	1.37E-05	1.37E-05	1.37E-05	3.87E-05
0.526	23.450	0.756	7.937	-1.23E-13	-1.23E-13	1.37E-05	3.87E-05
0.537	23.961	0.506	7.950	-1.35E-13	-1.35E-13	1.37E-05	3.87E-05
0.548	24.461	0.750	7.950	-9.07E-14	-9.07E-14	1.37E-05	3.87E-05
0.571	25.461	1.500	7.950	1.60E-05	1.60E-05	2.97E-05	8.99E-05
0.615	27.461	2.000	7.950	-1.39E-14	-1.39E-14	2.97E-05	8.99E-05
0.660	29.461	2.000	7.950	-2.34E-14	-2.34E-14	2.97E-05	8.99E-05
0.705	31.461	2.000	7.950	-8.90E-15	-8.90E-15	2.97E-05	8.99E-05
0.750	33.461	3.180	7.950	-3.85E-04	-3.85E-04	-3.55E-04	1.53E-03
0.848	37.821	2.430	7.950	-7.90E-03	-7.90E-03	-8.26E-03	-3.91E-02
0.859	38.321	0.500	7.950	1.44E-03	1.44E-03	-6.81E-03	-3.22E-02
0.870	38.821	0.648	7.950	1.61E-03	1.61E-03	-5.21E-03	-2.43E-02
0.888	39.616	0.648	7.950	3.33E-04	3.33E-04	-4.88E-03	-2.27E-02
0.899	40.116	0.500	7.950	1.70E-03	1.70E-03	-3.17E-03	-1.41E-02
0.910	40.616	0.518	7.950	1.23E-03	1.23E-03	-1.94E-03	-7.80E-03
0.922	41.151	0.772	7.875	-1.05E-03	-1.05E-03	-2.99E-03	-1.32E-02
0.945	42.159	1.043	7.625	-1.88E-03	-1.86E-03	-4.85E-03	-2.31E-02
0.969	43.236	0.783	7.375	-1.90E-03	-1.89E-03	-6.74E-03	-3.33E-02
0.980	43.725	0.690	7.250	-8.37E-04	-8.79E-04	-7.62E-03	-3.82E-02

NORMAL	FORCE COEFFICIENT	= 0.213489394
PITCHING	MOMENT COEFFICIENT (NOSE)	= 0.196527518
PITCHING	MOMENT COEFFICIENT (CG)	= 0.762921437
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA	= 1.5669788
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA	= 4.371217843
NORMAL	FORCE COEFFICIENT (NOSE)	= 0.336940447
PITCHING	MOMENT COEFFICIENT (NOSE) (NOSE)	= 0.577170154
PITCHING	MOMENT COEFFICIENT (CG) (NOSE)	= 0.604876259
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)	= 1.930526555
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)	= 3.465685735
NORMAL	FORCE COEFFICIENT (CYL)	= 0.039972162
PITCHING	MOMENT COEFFICIENT (NOSE) (CYL)	= 0.178057452
PITCHING	MOMENT COEFFICIENT (CG) (CYL)	=-0.037828069
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)	= 0.229023618
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)	=-0.216738871
NORMAL	FORCE COEFFICIENT (BT)	=-0.103423215
PITCHING	MOMENT COEFFICIENT (NOSE) (BT)	=-0.558700088
PITCHING	MOMENT COEFFICIENT (CG) (BT)	= 0.195873237
NORMAL	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)	=-0.592571372
PITCHING	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)	= 1.122270980

MAGNUS	FORCE COEFFICIENT	=-7.61633E-03
MAGNUS	MOMENT COEFFICIENT (NOSE)	=-0.038173328
MAGNUS	MOMENT COEFFICIENT (CG)	= 0.011453891
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA	=-0.043638374
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA	= 0.065625961
MAGNUS	FORCE COEFFICIENT (NOSE)	= 1.37064E-05
MAGNUS	MOMENT COEFFICIENT (NOSE) (NOSE)	= 3.87037E-05
MAGNUS	MOMENT COEFFICIENT (CG) (NOSE)	= 9.38067E-06
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)	= 7.85317E-05
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)	= 5.37473E-05
MAGNUS	FORCE COEFFICIENT (CYL)	=-1.95856E-03
MAGNUS	MOMENT COEFFICIENT (NOSE) (CYL)	=-7.83998E-03
MAGNUS	MOMENT COEFFICIENT (CG) (CYL)	= 9.69005E-04
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)	=-0.011221720
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)	= 5.55199E-03
MAGNUS	FORCE COEFFICIENT (BT)	=-5.67148E-03
MAGNUS	MOMENT COEFFICIENT (NOSE) (BT)	=-0.030372055
MAGNUS	MOMENT COEFFICIENT (CG) (BT)	= 0.010475506
MAGNUS	FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)	=-0.032495186
MAGNUS	MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)	= 0.060020226

Figure C-9. Rotating Band On, $\alpha = 10°$, P = 0° rpm

```
REF. LENGTH (L):                  44.616    IN.
REF. DIAMETER (D):                7.95      IN.
ROTATING BAND:                    ON
MACH NO.:                         0.94
ANGLE OF ATTACK (ALPHA):          10     DEG.
SPIN RATE (P):                    4900      REV/MIN
TIP SPEED RATIO (PD/2V):          0.16202742[illegible]
X CG/L                            0.6251120[illegible]
```

ZI/L	ZI (IN)	DZI (IN)	DIA. (IN)	CNI LOCAL	CN	CN SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.123	5.130	2.125	0.0442	0.[illegible]432	0.0432	0.0170
0.160	7.139	4.685	3.812	0.0652	0.0642	0.1074	0.0746
0.280	12.492	5.354	5.375	0.0830	0.0820	0.1894	0.2035
0.400	17.846	4.908	6.875	0.0801	0.0795	0.2689	0.3819
0.500	22.308	2.302	7.718	0.0328	0.0327	0.3016	0.4736
0.503	22.449	0.571	7.750	0.0109	0.0109	0.3125	0.5043
0.526	23.450	0.756	7.937	0.0165	0.0165	0.3290	0.5530
0.537	23.961	0.506	7.950	0.0106	0.0106	0.3395	0.5848
0.548	24.461	0.750	7.950	0.0148	0.0148	0.3543	0.6304
0.571	25.461	1.500	7.950	0.0255	0.0255	0.3798	0.7120
0.615	27.461	2.000	7.950	0.0132	0.0132	0.3931	0.7578
0.660	29.461	2.000	7.950	-0.0078	-0.0078	0.3853	0.7289
0.705	31.461	2.000	7.950	0.0012	0.0012	0.3865	0.7338
0.750	33.461	3.180	7.950	0.0026	0.0026	0.3891	0.7446
0.848	37.821	2.430	7.950	0.0172	0.0172	0.4063	0.8265
0.859	38.321	0.500	7.950	0.0072	0.0072	0.4135	0.8613
0.870	38.821	0.648	7.950	0.0090	0.0090	0.4225	0.9052
0.888	39.616	0.648	7.950	0.0084	0.0084	0.4309	0.9469
0.899	40.116	0.500	7.950	0.0106	0.0106	0.4415	1.0004
0.910	40.616	0.518	7.950	0.0064	0.0064	0.4479	1.0333
0.922	41.151	0.772	7.875	-0.0011	-0.0011	0.4468	1.0275
0.945	42.159	1.043	7.625	-0.0276	-0.0274	0.4194	0.882[illegible]
0.969	43.236	0.783	7.375	-0.0105	-0.0104	0.4090	0.8256
0.980	43.725	0.690	7.250	-0.0043	-0.0043	0.4047	0.0020

```
NORMAL   FORCE COEFFICIENT                                    = 0.4047[illegible]534
PITCHING MOMENT COEFFICIENT (NOSE)                            = 0.802[illegible]449
PITCHING MOMENT COEFFICIENT (CG)                              = 0.61[illegible]318
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT ALPHA               = 2.31[illegible]4716
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA         = 3.5[illegible]6711
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE           = 2.4[illegible]40909
MOMENT   COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE            = [illegible]42912

NORMAL   FORCE COEFFICIENT (NOSE)                             = 0.339523[illegible]95
PITCHING MOMENT COEFFICIENT (NOSE) (NOSE)                     = 0.384[illegible]28384
PITCHING MOMENT COEFFICIENT (CG) (NOSE)                       = 0.60[illegible]90880
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)        = 1.94532805
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)   = 3.473733560
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)    = 2.095471121
MOMENT   COEFFICIENT (CG) [illegible]IVE WRT SPIN RATE (NOSE) = 3.741[illegible]105

NORMAL   FORCE COEFFICIENT (CYL)                              = 0.108392053
PITCHING MOMENT COEFFICIENT (NOSE) (CYL)                      = 0.448437842
PITCHING MOMENT COEFFICIENT (CG) (CYL)                        =-0.068214515
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)         = 0.620983420
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (CYL)   =-0.390840380
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)     = 0.668911767
MOMENT   COEFFICIENT (CG) DERIVATIVE WPT SPIN PATE (CLY)      =-0.421005973

NORMAL   FORCE COEFFICIENT (BT)                               =-0.043203314
PITCHING MOMENT COEFFICIENT (NOSE) (BT)                       =-0.231218786
PITCHING MOMENT COEFFICIENT (CG) (BT)                         = 0.079653953
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)          =-0.247536755
PITCHING MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (BT)    = 0.460840380
NORMAL   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)      =-0.266641379
MOMENT   COEFFICIENT (CG) DEPIVATIVE WRT SPIN RATE (BT)       = 0.491607834
```

ZI/L (IN)	ZI	DZI	DIA. (IN)	CYI LOCAL	CY	CY SUM	CM
******	*******	******	******	*******	*******	*******	*******
0.070	3.12	5.130	2.125	8.40E-15	8.21E-15	8.21E-15	3.23E-15
0.160	7.139	4.685	3.812	-1.17E-13	-1.15E-13	-1.07E-13	-1.00E-13
0.280	12.492	5.354	5.375	-3.11E-13	-3.07E-13	-4.14E-13	-5.82E-13
0.400	17.846	4.908	6.875	-1.66E-13	-1.65E-13	-5.79E-13	-9.53E-13
0.500	22.308	2.302	7.718	8.90E-13	8.87E-13	3.08E-13	1.54E-12
0.503	22.449	0.571	7.750	5.89E-04	5.87E-04	5.87E-04	1.66E-03
0.526	23.450	0.756	7.937	1.03E-04	1.03E-04	6.90E-04	1.96E-03
0.537	23.961	0.506	7.950	-3.14E-05	-3.14E-05	6.59E-04	1.87E-03
0.548	24.461	0.750	7.950	-1.72E-03	-1.72E-03	-1.0[illegible]-03	-3.42E-03
0.571	25.461	1.500	7.950	3.12E-03	3.12E-03	2.06E-03	6.57E-03
0.615	27.461	2.000	7.950	2.70E-03	2.70E-03	4.76E-03	1.59E-02
0.660	29.461	2.000	7.950	1.28E-03	1.28E-03	6.04E-03	2.06E-02
0.705	31.461	2.000	7.950	6.40E-04	6.40E-04	6.69E-03	2.32E-02
0.750	33.461	3.180	7.950	2.65E-03	2.65E-03	9.33E-03	3.43E-02
0.848	37.821	2.430	7.950	5.88E-03	5.88E-03	1.52E-02	6.23E-02
0.859	38.321	0.500	7.950	3.81E-03	3.81E-03	1.90E-02	8.06E-02
0.870	38.821	0.648	7.950	3.55E-03	3.55E-03	2.26E-02	9.80E-02
0.888	39.616	0.648	7.950	1.34E-03	1.34E-03	2.39E-02	1.05E-01
0.899	40.116	0.500	7.950	1.23E-03	1.23E-03	2.51E-02	1.11E-01
0.910	40.616	0.518	7.950	-3.73E-04	-3.73E-04	2.48E-02	1.09E-01
0.922	41.151	0.772	7.875	1.12E-03	1.11E-03	2.59E-02	1.15E-01
0.945	42.159	1.043	7.625	5.57E-03	5.53E-03	3.14E-02	1.44E-01
0.969	43.236	0.783	7.375	-9.70E-04	-9.61E-04	3.04E-02	1.39E-01
0.980	43.725	0.690	7.250	-1.48E-03	-1.47E-03	2.90E-02	1.31E-0[illegible]

```
MAGNUS   FORCE COEFFICIENT                                    = 0.028971646
MAGNUS   MOMENT COEFFICIENT (NOSE)                            = 0.130721838
MAGNUS   MOMENT COEFFICIENT (CG)                              =-0.029084201
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT ALPHA               = 0.165995306
MAGNUS   MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA         =-0.166640194
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE           = 0.178807050
MAGNUS   COEFFICIENT (CG) DERIVATIVE WRT SPIN PATE            =-0.179501712

MAGNUS   FORCE COEFFICIENT (NOSE)                             = 6.58461E-04
MAGNUS   MOMENT COEFFICIENT (NOSE) (NOSE)                     = 1.86630E-03
MAGNUS   MOMENT COEFFICIENT (CG) (NOSE)                       = 4.43699E-04
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT ALPHA (NOSE)        = 3.77270E-03
MAGNUS   MOMENT COEFFICIENT (CG) DERIVATIVE WRT ALPHA (NSE)   = 2.54221E-03
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (NOSE)    = 4.06389E-03
MAGNUS   COEFFICIENT (GC) DERIVATIVE WRT SPIN RATE (NOSE)     = 2.73842E-03

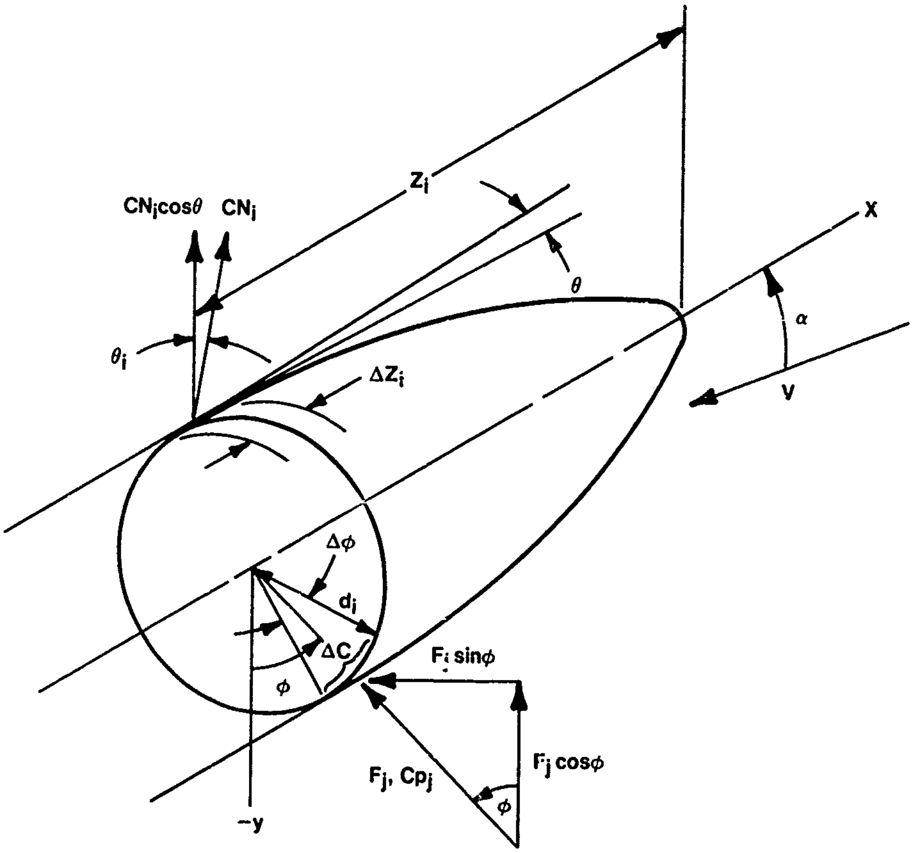
MAGNUS   FORCE COEFFICIENT (CYL)                              = 0.024107206
MAGNUS   MOMENT COEFFICIENT (NOSE) (CYL)                      = 0.107112407
MAGNUS   MOMENT COEFFICIENT (CG) (CYL)                        =-0.022540083
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT ALPHA (CYL)         = 0.138124116
MAGNUS   MOMENT COEFFICIENT (CG) DERIVATIVE WPT ALPHA (CYL)   =-0.129145163
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (CYL)     = 0.148784724
MAGNUS   COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (CLY)      =-0.139112763

MAGNUS   FORCE COEFFICIENT (BT)                               = 4.20598E-03
MAGNUS   MOMENT COEFFICIENT (NOSE) (BT)                       = 0.021743132
MAGNUS   MOMENT COEFFICIENT (CG) (BT)                         =-6.98782E-03
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT ALPHA (BT)          = 0.024098485
MAGNUS   MOMENT COEFFICIENT (CG) DERIVATIVE WPT ALPHA (BT)    =-0.129145163
MAGNUS   FORCE COEFFICIENT DERIVATIVE WRT SPIN RATE (BT)      = 0.025958439
MAGNUS   COEFFICIENT (CG) DERIVATIVE WRT SPIN RATE (BT)       =-0.043127367
```

Figure C-10. Rotating Band On, $\alpha = 10°$, P = 4900 rpm

The following are derivations of selected data reduction terms included in Appendix C.

1. Derivation of Local Force and Moment Coefficient:



At pressure tap location Z_i: $\Delta P_j = Cp_j \, q$

$$F_j = Cp_j \, q \, S_j$$

$$q = \frac{\rho v^2}{2}$$

$$S_j = \Delta C \, \Delta Z_i$$

$$\Delta C = \frac{di}{2} \sin\Delta\phi$$

$$S_j = \frac{di}{2} \Delta Z_i \sin\Delta\phi$$

$$F_j = Cp_j \, q \frac{di}{2} \Delta Z_i \sin\Delta\phi$$

$$N_i = \sum_{j=1}^{360/\Delta\phi} F_j \cos\phi_j$$

$$N_i = \sum_{j=1}^{360/\Delta\phi} C_{p_j}\, q\, \frac{d_i}{2}\, \Delta Z_i \sin\Delta\phi \cos\phi_j$$

$$C_{N_i} = \frac{N_i}{qs}$$

$$S = \frac{\pi d^2}{4}$$

$$C_{N_i} = \sum_{j=1}^{360/\Delta\phi} 2\, C_{p_j} \frac{d_i\, \Delta Z_i \sin\Delta\phi \cos\phi_j}{\pi d^2}$$

$$C_{N_i} = \frac{2\, d_i\, \Delta Z_i \sin\Delta\phi}{\pi d^2} \sum_{j=1}^{360/\Delta\phi} C_{p_j} \cos\phi_j$$

similarly:

$$C_{y_i} = \frac{2\, d_i\, \Delta Z_i \sin\Delta\phi}{\pi d^2} \sum_{j=1}^{360/\Delta\phi} C_{p_j} \sin\phi_j$$

$$\Delta\phi = 10^\circ$$

$$j = 1 \longrightarrow 36$$

$$C_N = \sum_{i=1}^{27} C_{N_i}\, \Delta Z_i \cos\theta_i$$

For this report, $i = 1 \longrightarrow 27$ includes data from the 19 tap locations used in the Ames test model, plus data from 8 ogive locations obtained in reference 7.

where:

$$\Delta Z_i = \frac{Z_{i+1} - Z_i}{2} + \frac{Z_i - Z_{i-1}}{2}$$

$$\Delta Z_i = \frac{Z_{i+1} - Z_{i-1}}{2}$$

$$@ \quad Z_i = 1 \qquad Z_{i-1} = L - Z_{i-1}$$

$$@ \quad Z_i = 27 \qquad Z_{i+1} = L$$

similarly:

$$C_y = \sum_{i=1}^{27} C_{y_i} \Delta Z_i \cos\theta$$

$$M_i = N_i Z_i$$

$$M_i = \sum_{j=1}^{360/\Delta\phi} F_j Z_i \cos\phi_j$$

$$M_i = \sum_{j=1}^{360/\Delta\phi} C_{p_j} q \frac{d_i}{2} \Delta Z_i \sin\Delta\phi \, Z_i \cos\phi_j$$

$$C_{m_i} = \frac{M_i}{qsd}$$

$$S = \frac{\pi d^2}{4}$$

$$C_{m_i} = \sum_{j=1}^{360/\Delta\phi} \frac{2 C_{p_j} d_i \Delta Z_i Z_i \sin\Delta\phi \cos\phi_j}{\pi d^3}$$

$$C_{m_i} = \frac{2 d_i \Delta Z_i Z_i \sin\Delta\phi}{\pi d^3} \sum_{j=1}^{360/\Delta\phi} C_{p_j} \cos\phi_j$$

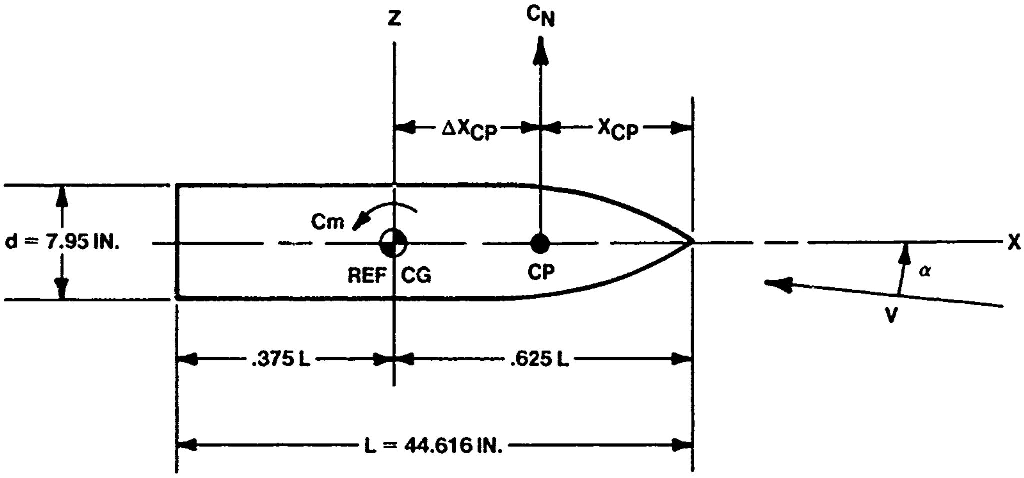
similarly:

$$C_{n_i} = \frac{2 d_i \Delta Z_i Z_i \sin\Delta\phi}{\pi d^3} \sum_{j=1}^{360/\Delta\phi} C_{p_j} \sin\phi_j$$

$$C_{m_{nose}} = \sum_{i=1}^{27} C_{m_i} \Delta Z_i$$

$$C_{n_{nose}} = \sum_{i=1}^{27} C_{n_i} \Delta Z_i.$$

2. Derivation of Normal Force and Magnus Force Centers of Pressure Locations:



$$X_{cp} + \Delta X_{cp} = .625L$$

$$\frac{X_{cp}}{L} + \frac{\Delta X_{cp}}{L} = .625$$

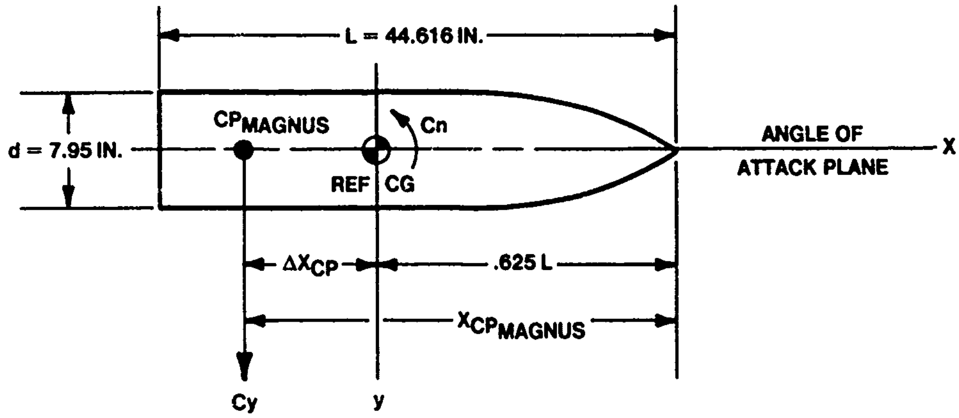
$$\frac{X_{cp}}{L} + \frac{\Delta X_{cp}}{L}\frac{d}{L} = .625$$

$$\frac{X_{cp}}{L} = .625 - \frac{d}{L}\frac{\Delta X_{cp}}{d}$$

$$\frac{\Delta X_{cp}}{d} = \frac{C_{m_\alpha}}{C_{N_\alpha}}$$

$$\frac{X_{cp}}{L} = .625 - \frac{7.95}{44.616}\frac{C_{m_\alpha}}{C_{N_\alpha}}$$

$$\frac{X_{cp}}{L} = .625 - .1782\frac{C_{m_\alpha}}{C_{N_\alpha}}$$



$$X_{cp_{MAGNUS}} = \Delta X_{cp_{MAGNUS}} + .625L$$

$$\frac{X_{cp_{MAGNUS}}}{L} = \frac{\Delta X_{cp_{MAGNUS}}}{L} + .625$$

$$\frac{X_{cp_{MAGNUS}}}{L} = \frac{\Delta X_{cp_{MAGNUS}}}{L} \cdot \frac{d}{L} + .625$$

$$\frac{X_{cp_{MAGNUS}}}{L} = .1782 \frac{\Delta X_{cp_{MAGNUS}}}{d} + .625$$

$$\frac{\Delta X_{cp_{MAGNUS}}}{d} = \frac{C_{n_p}}{C_{y_p}}$$

$$\frac{X_{cp_{MAGNUS}}}{L} = .625 + .1782 \frac{C_{n_p}}{C_{y_p}}$$

APPENDIX D

ENGINEERING DRAWINGS OF WIND TUNNEL MODEL COMPONENTS

Appendix D contains the engineering drawings of the model and sting components, including an assembly drawing.

Figure

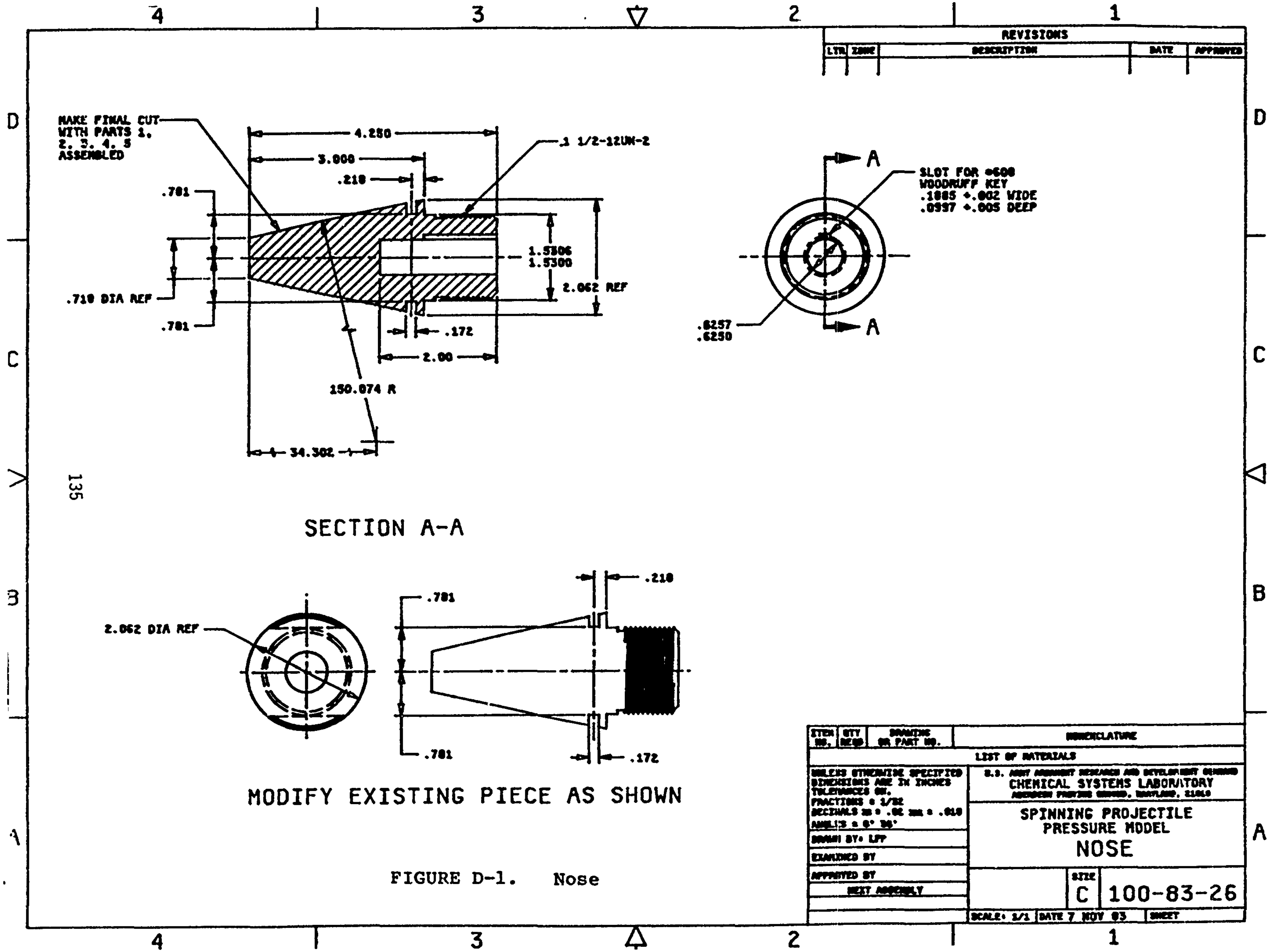


FIGURE D-1. Nose

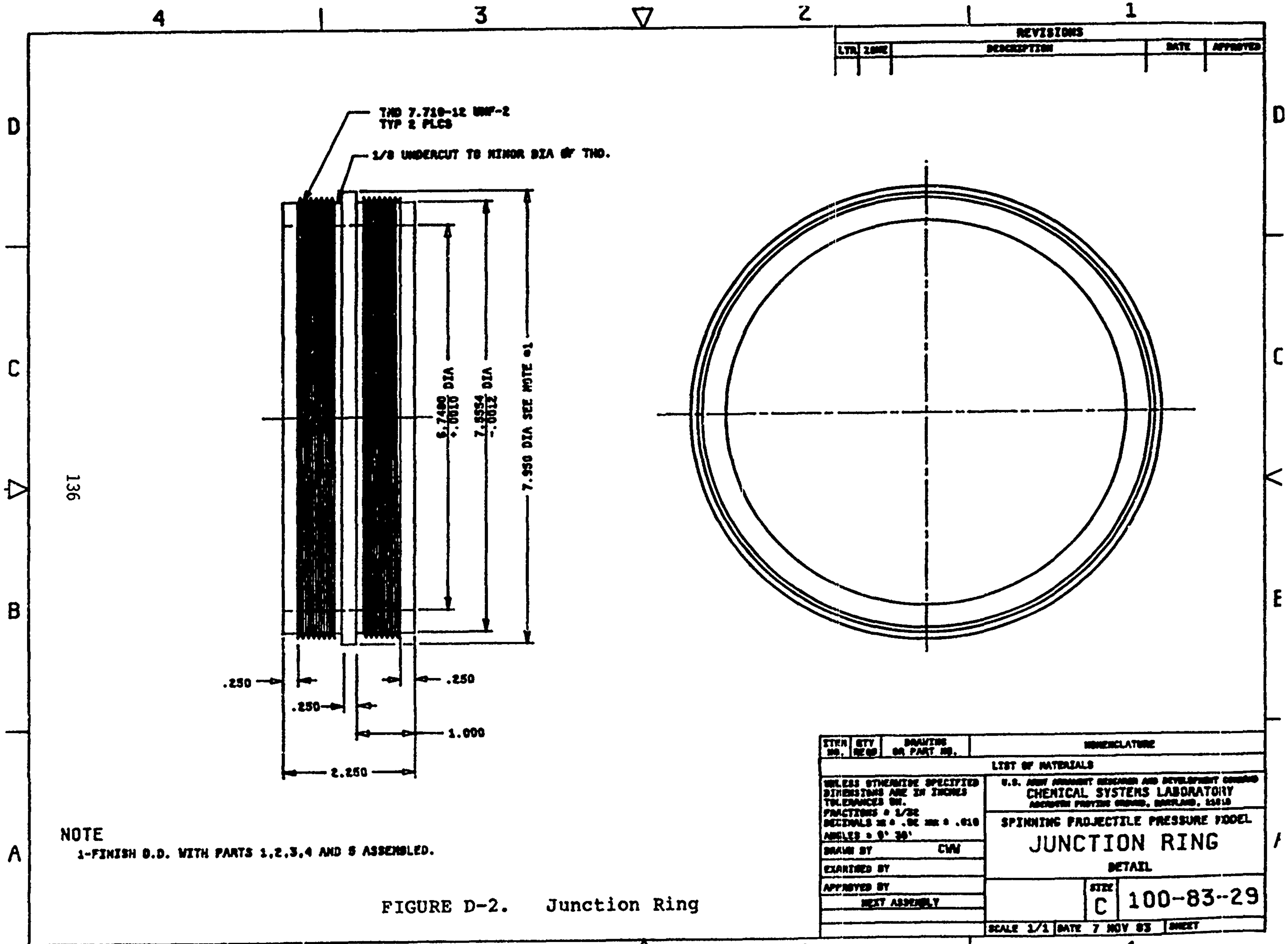


FIGURE D-2. Junction Ring

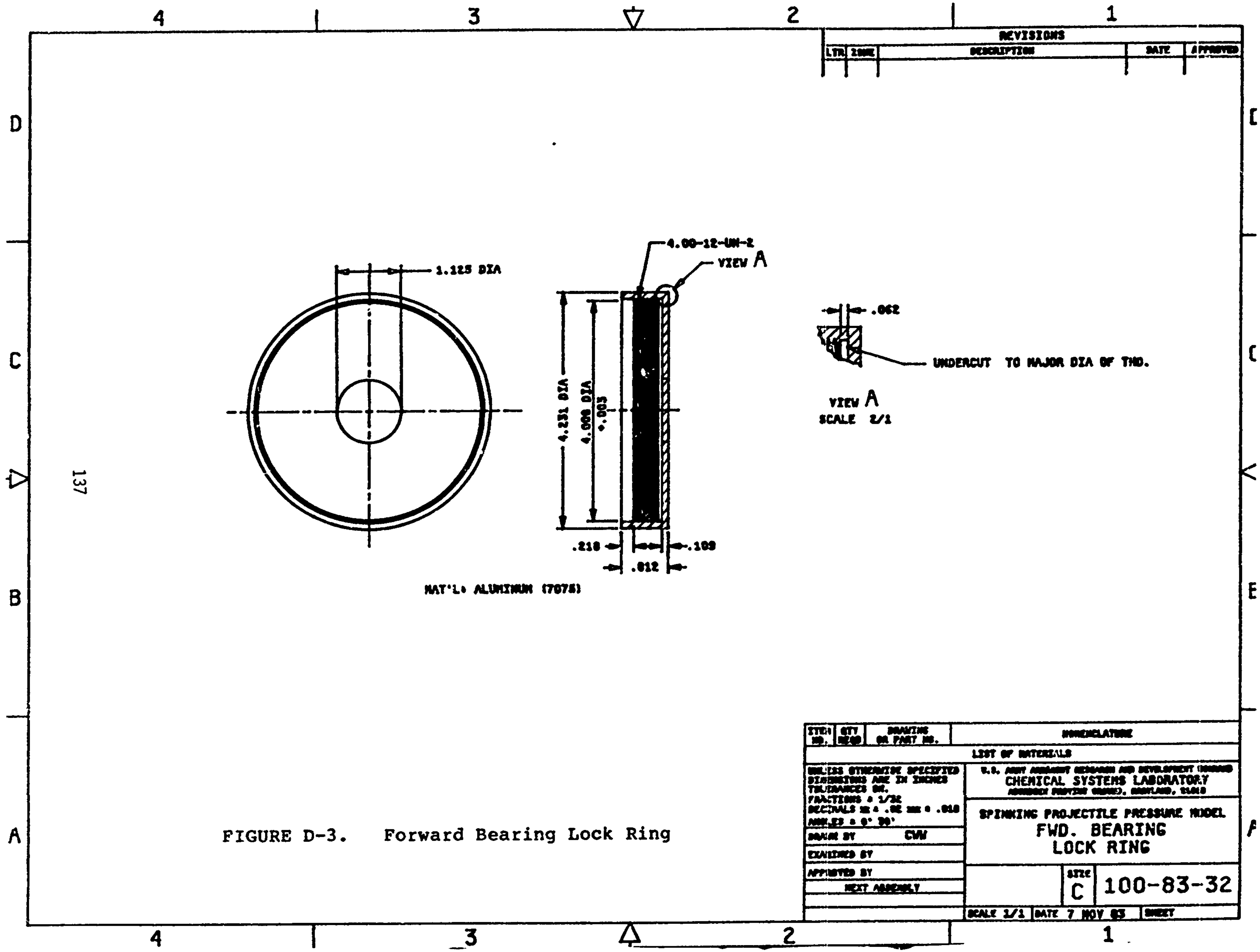


FIGURE D-3. Forward Bearing Lock Ring

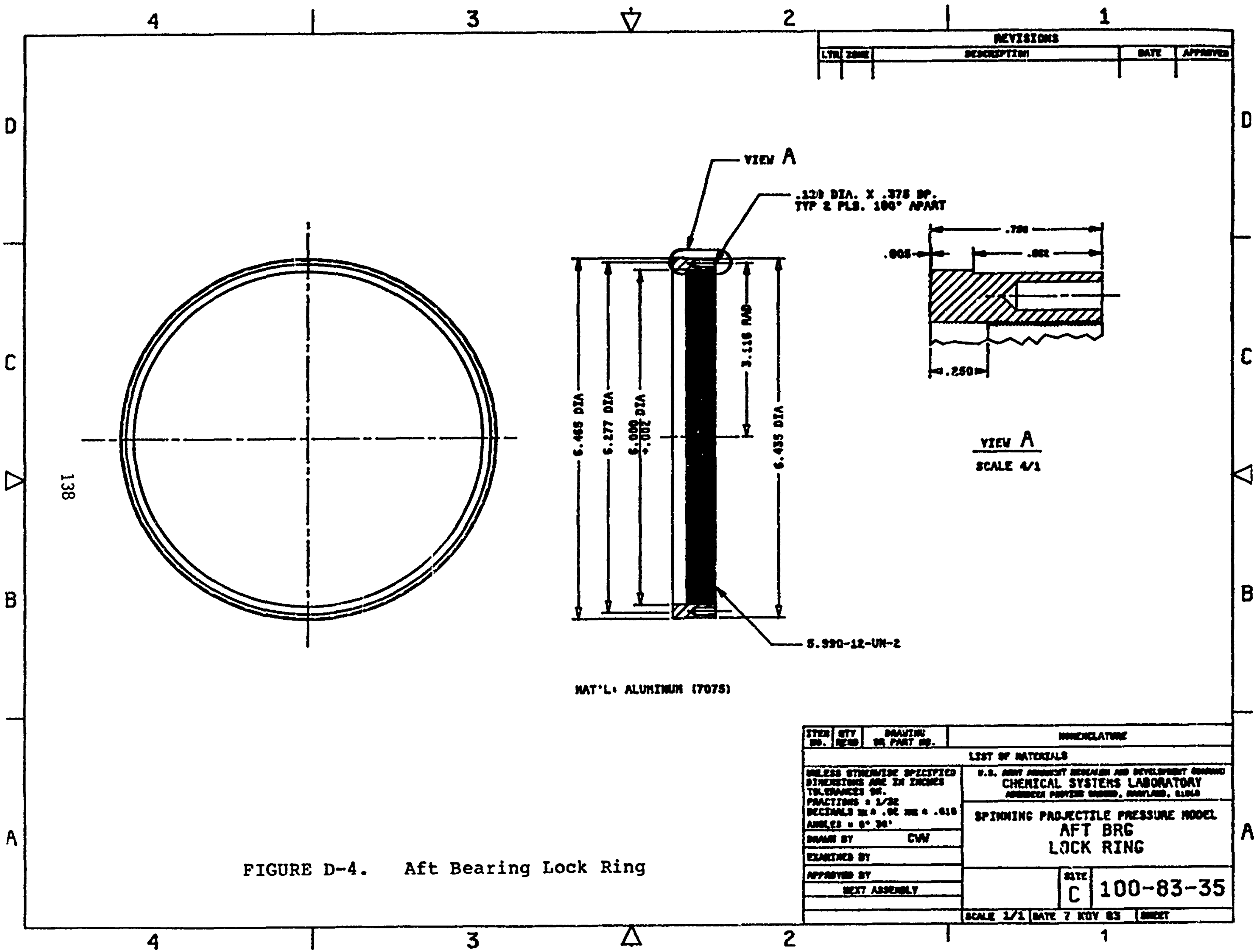


FIGURE D-4. Aft Bearing Lock Ring

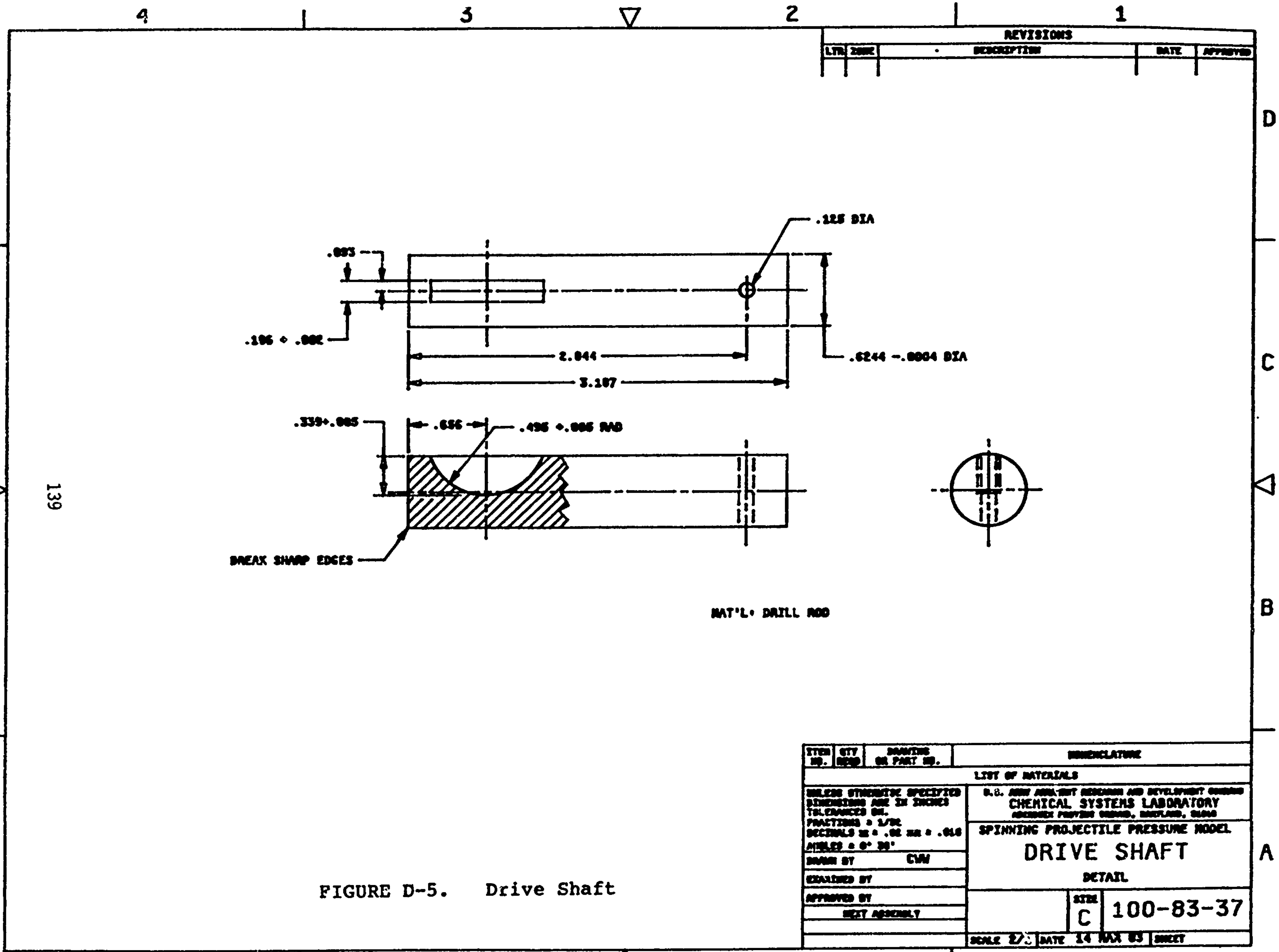


FIGURE D-5. Drive Shaft

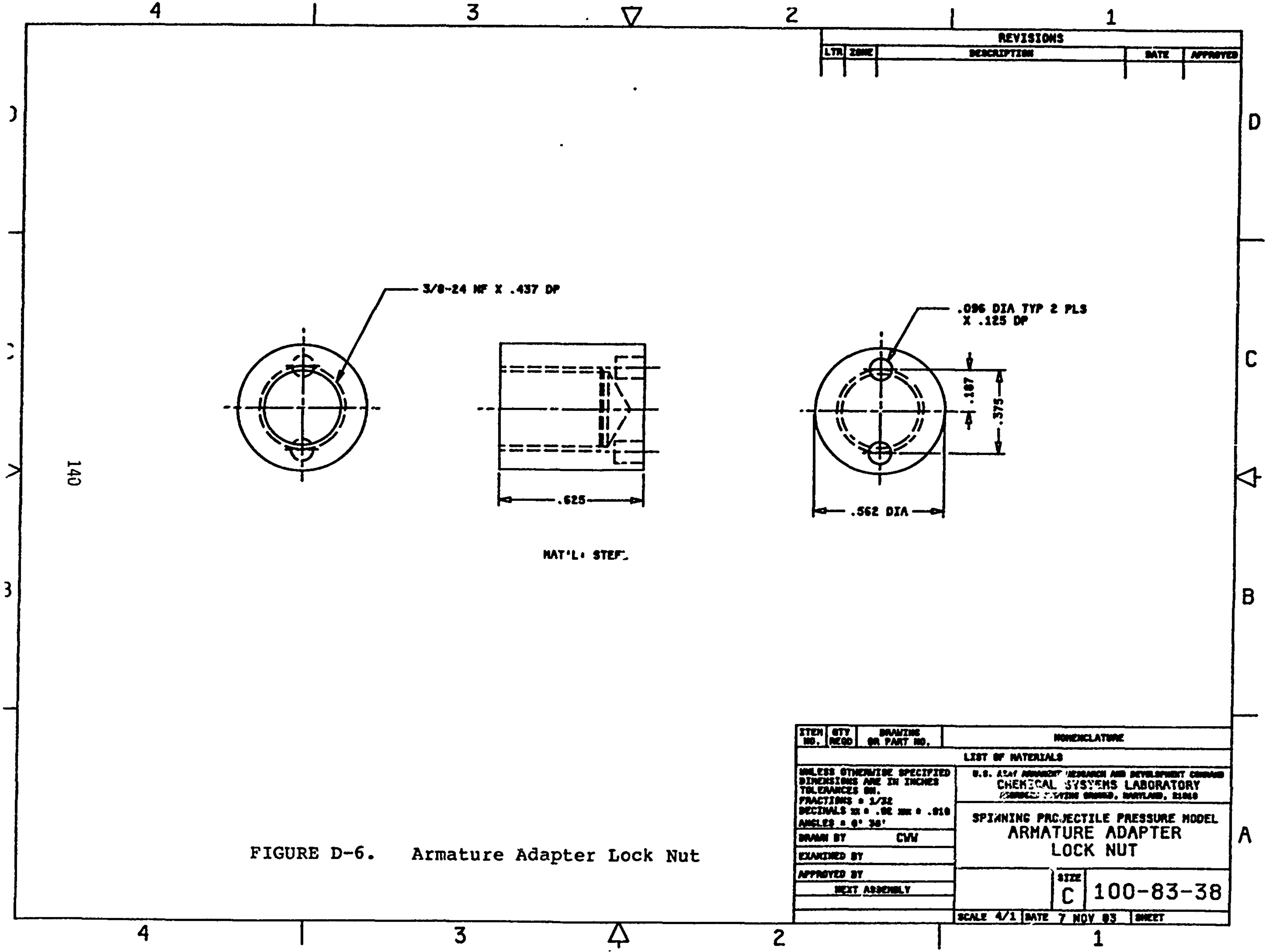


FIGURE D-6. Armature Adapter Lock Nut

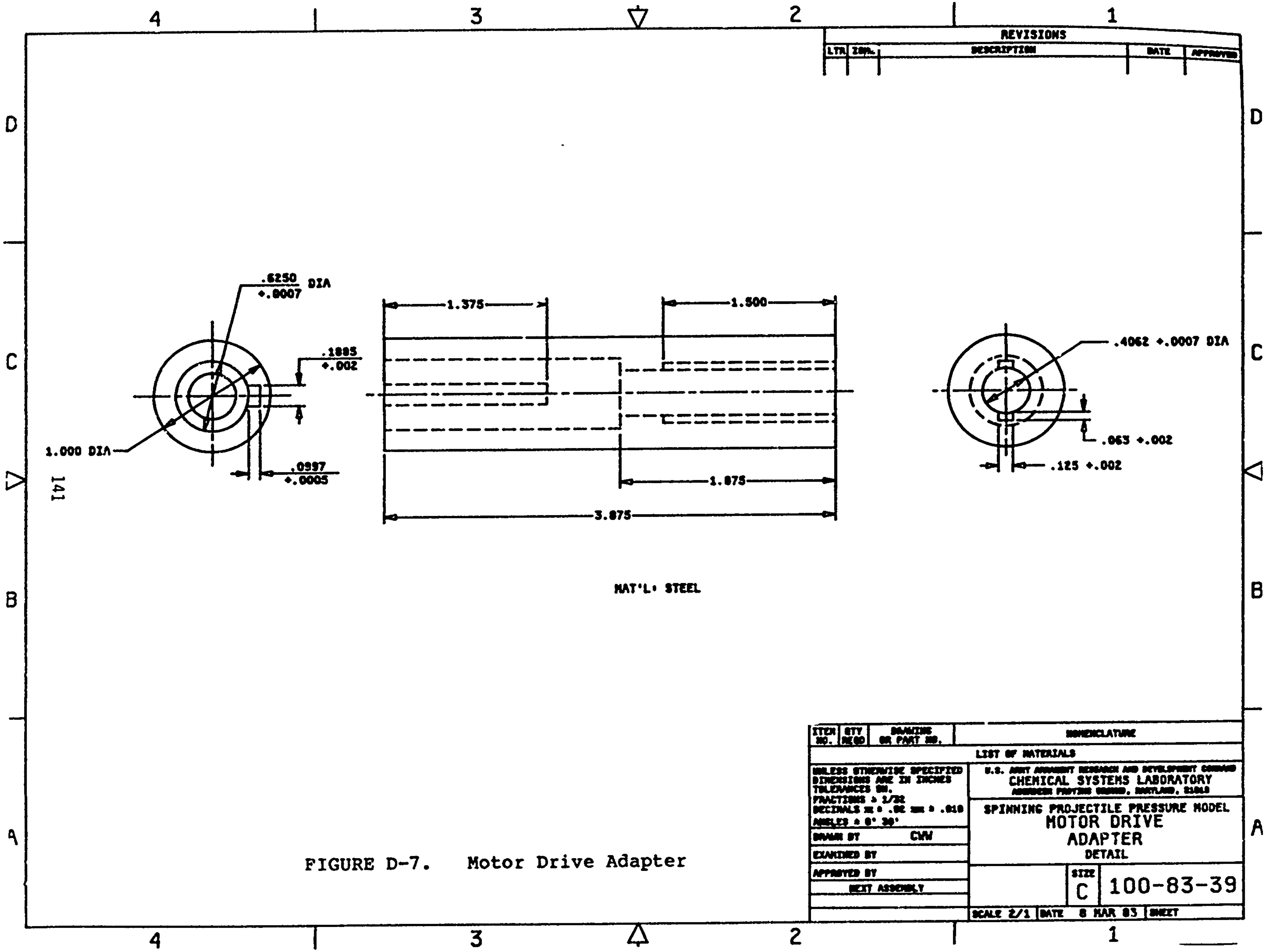


FIGURE D-7. Motor Drive Adapter

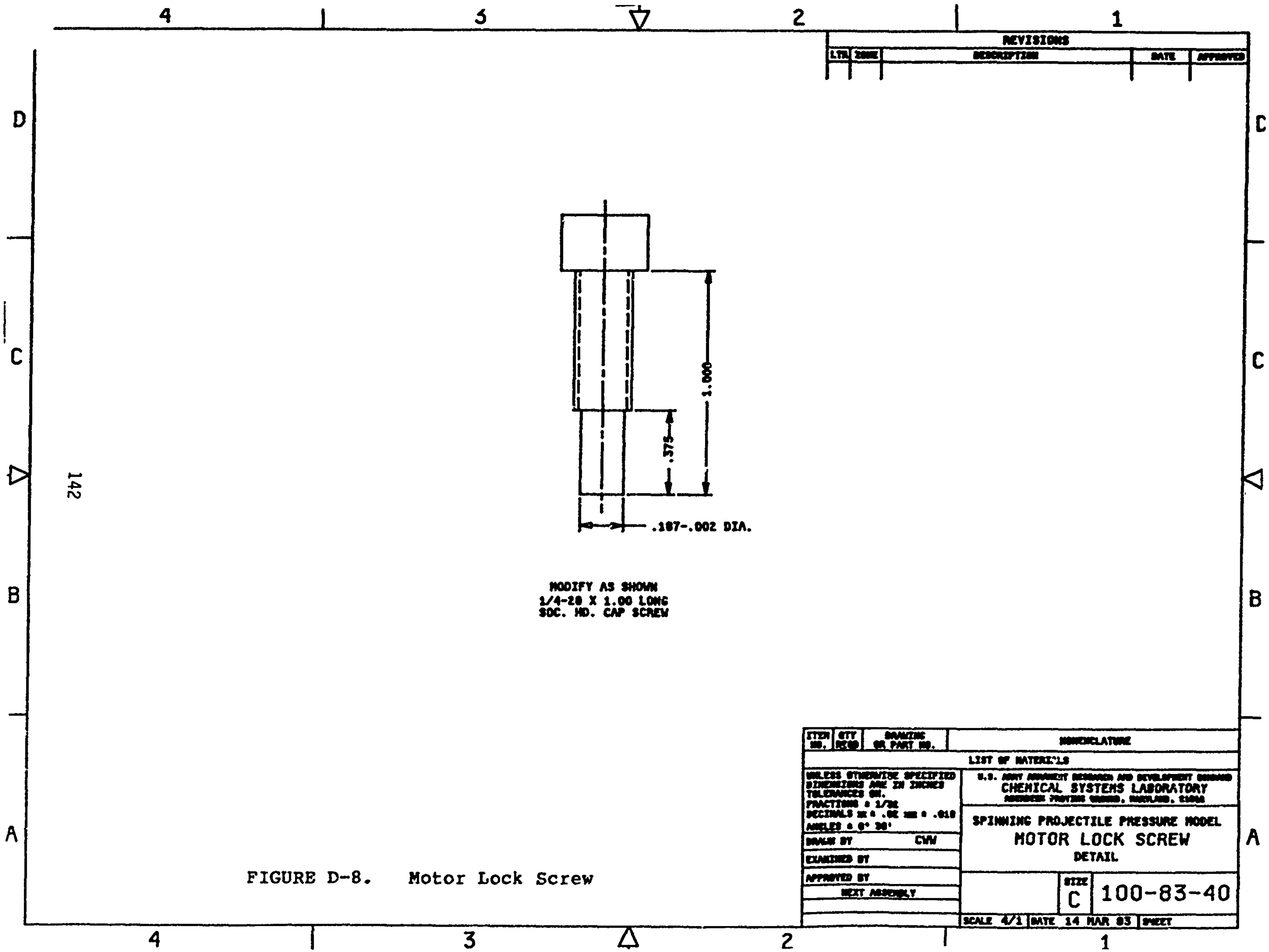


FIGURE D-8. Motor Lock Screw

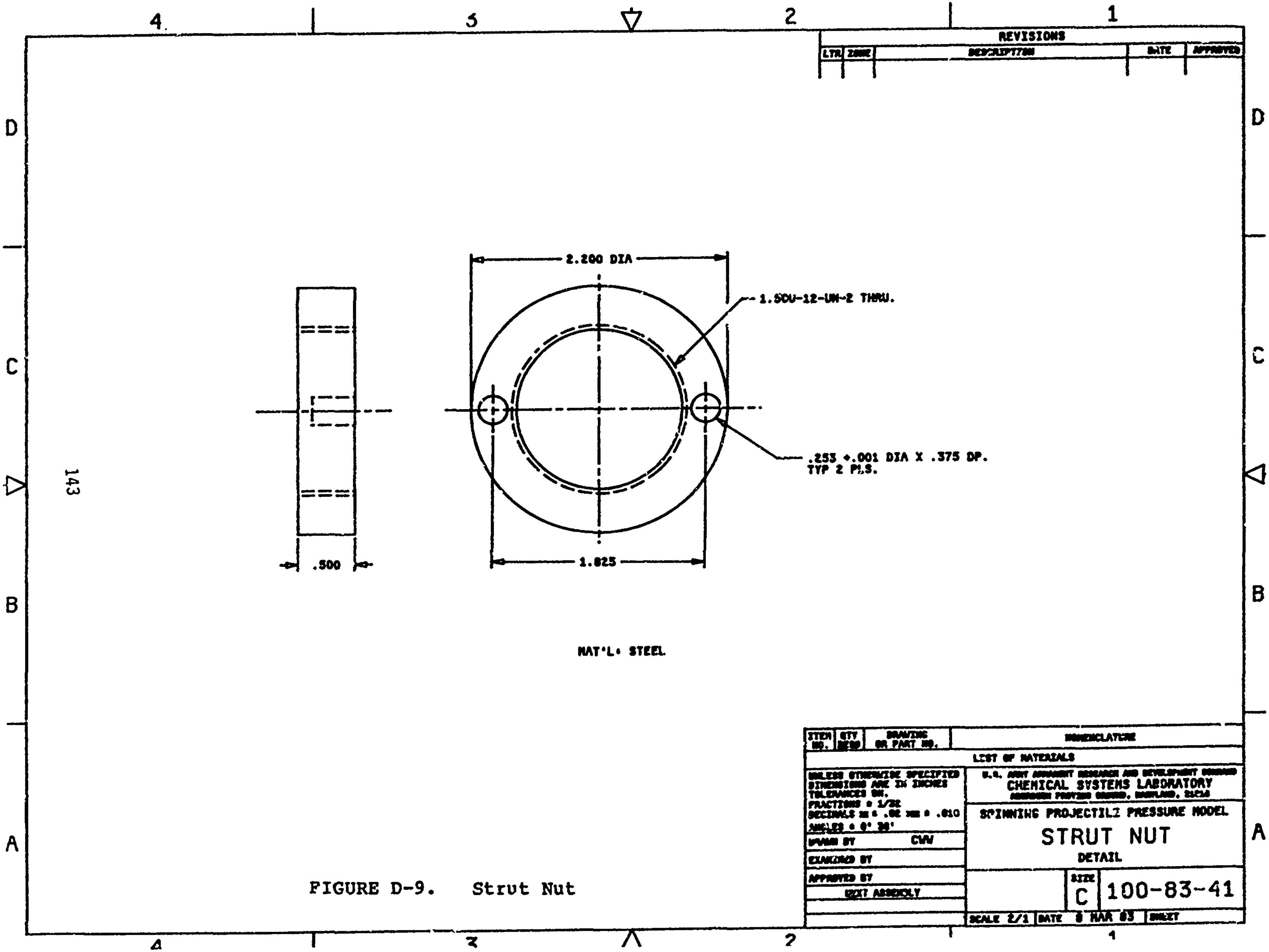


FIGURE D-9. Strut Nut

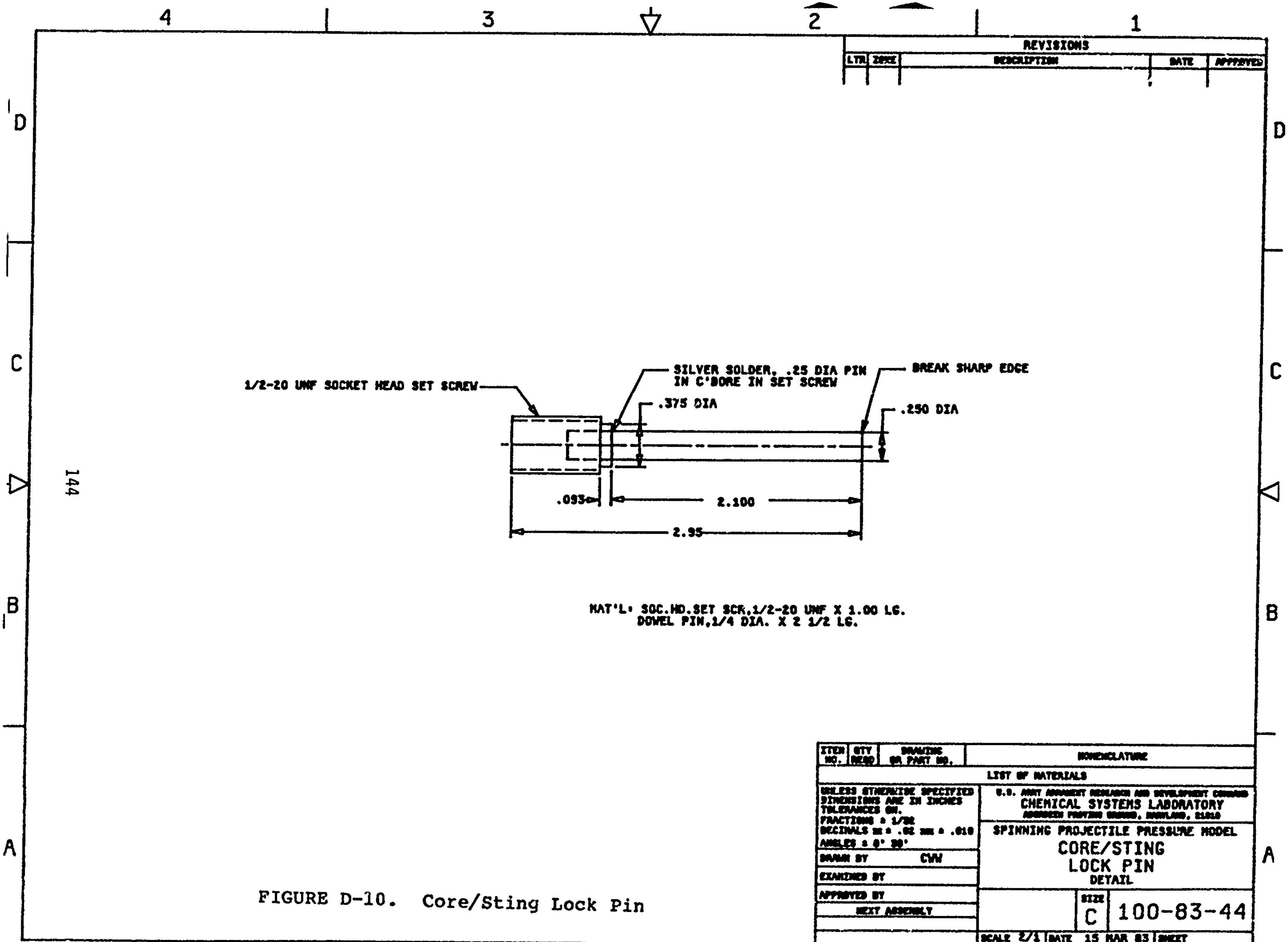


FIGURE D-10. Core/Sting Lock Pin

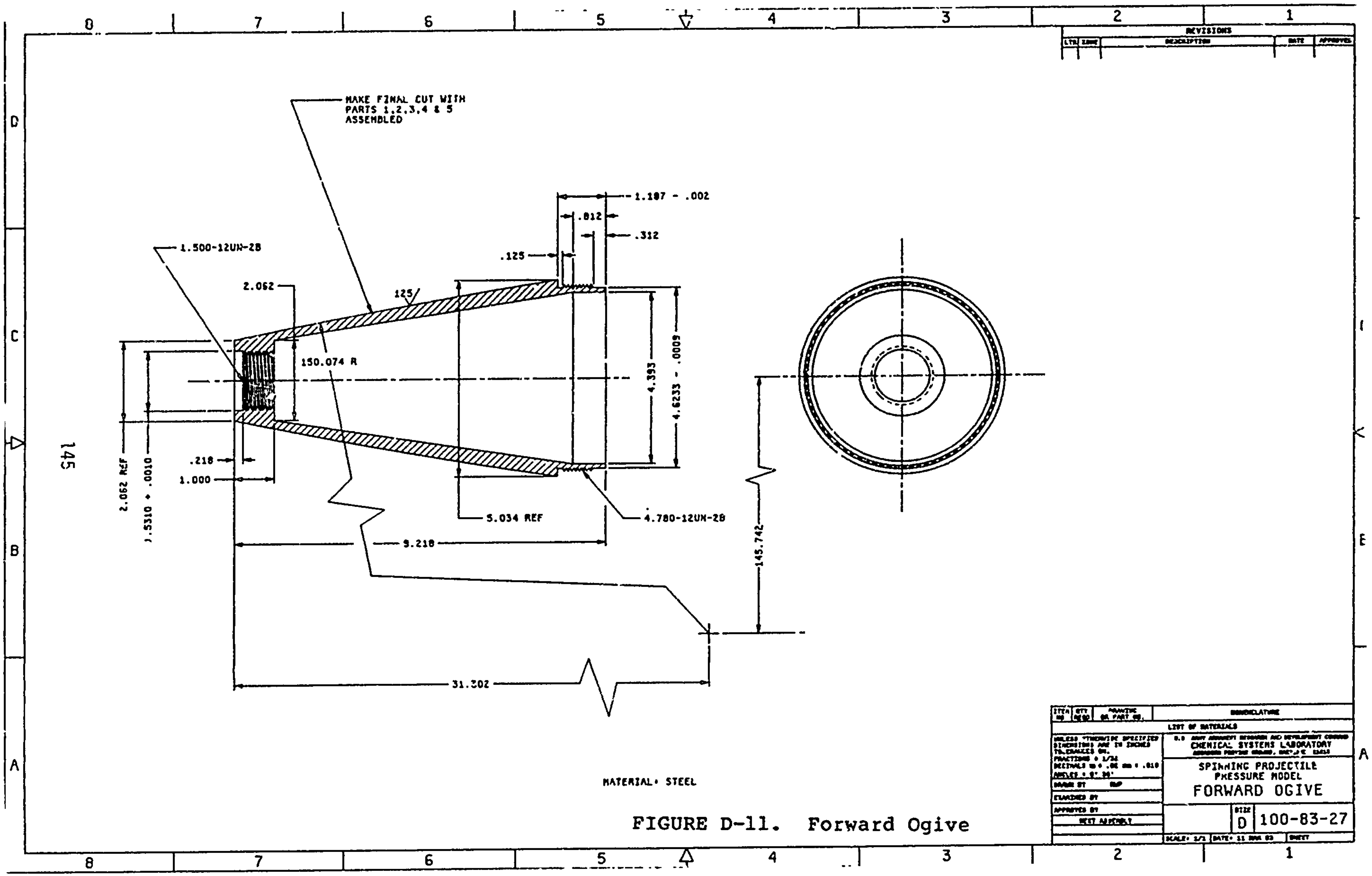


FIGURE D-11. Forward Ogive

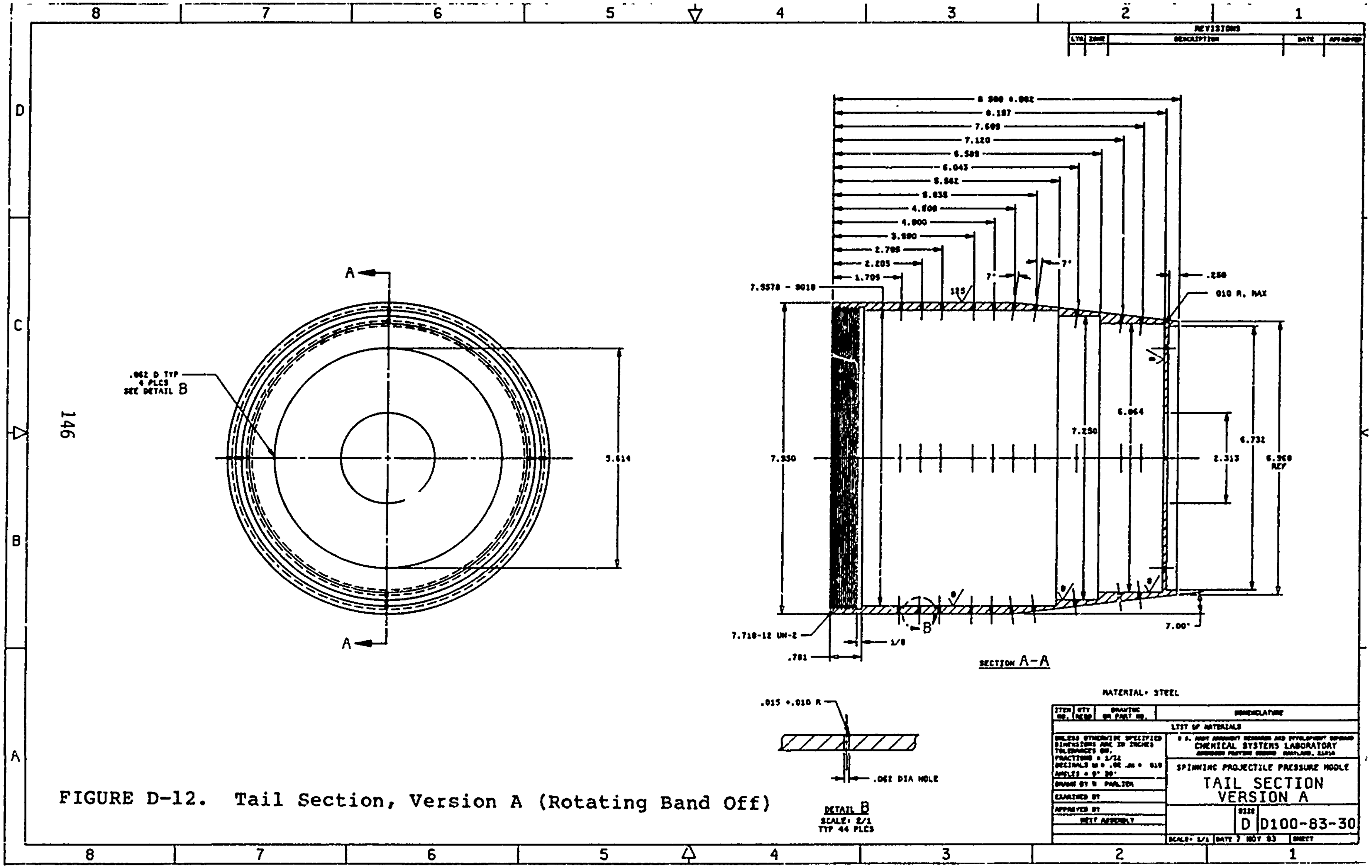


FIGURE D-12. Tail Section, Version A (Rotating Band Off)

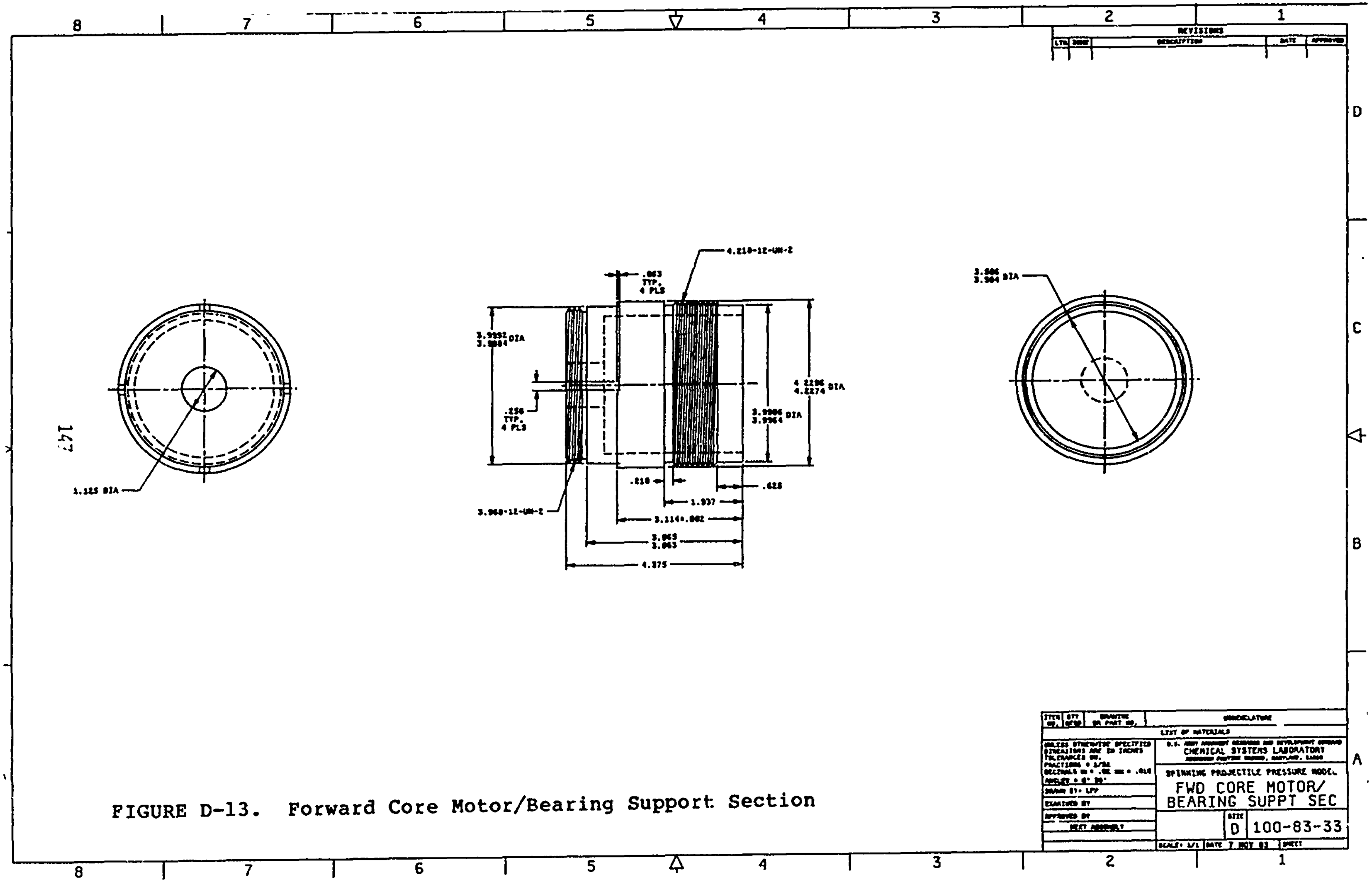


FIGURE D-13. Forward Core Motor/Bearing Support Section

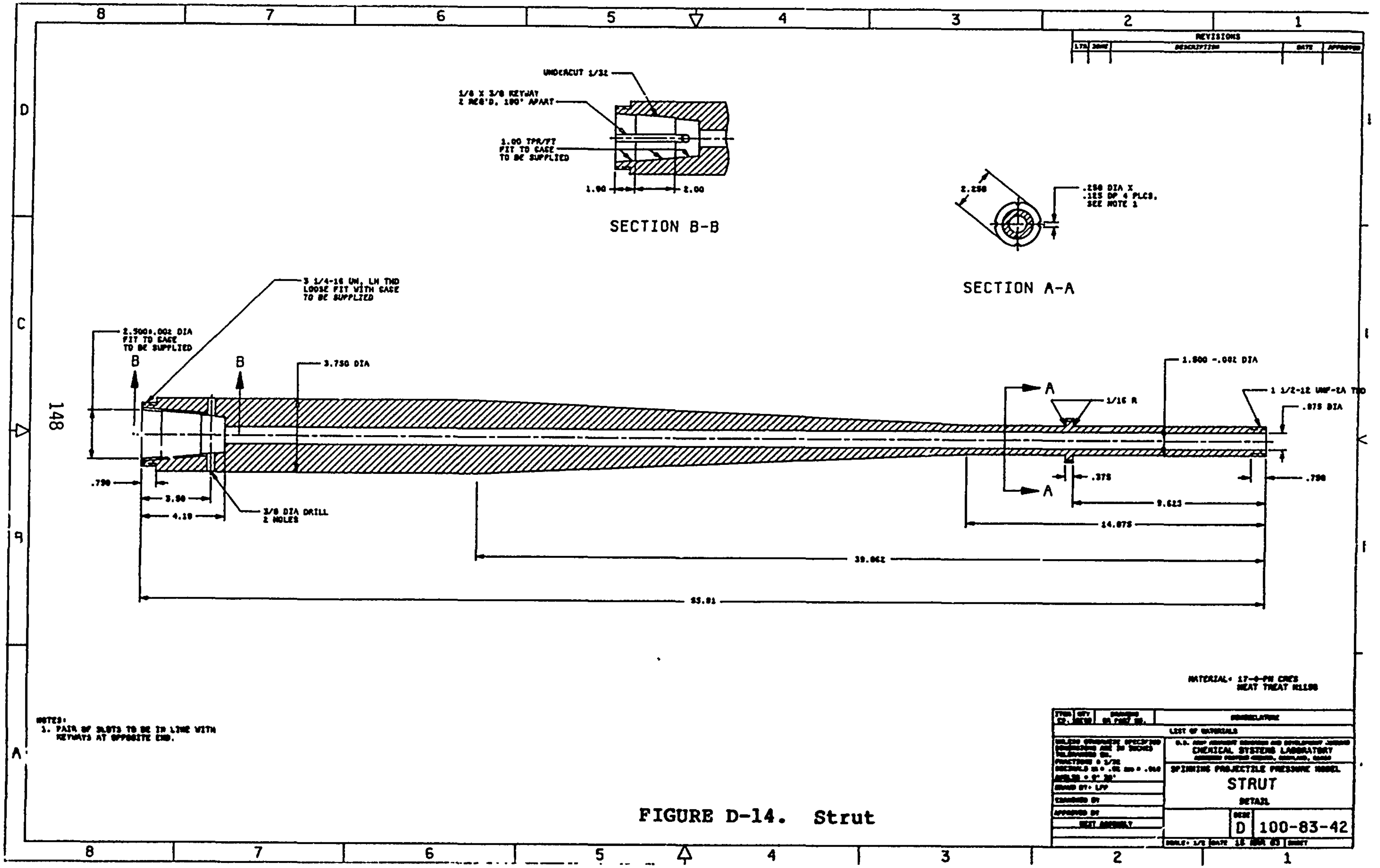


FIGURE D-14. Strut

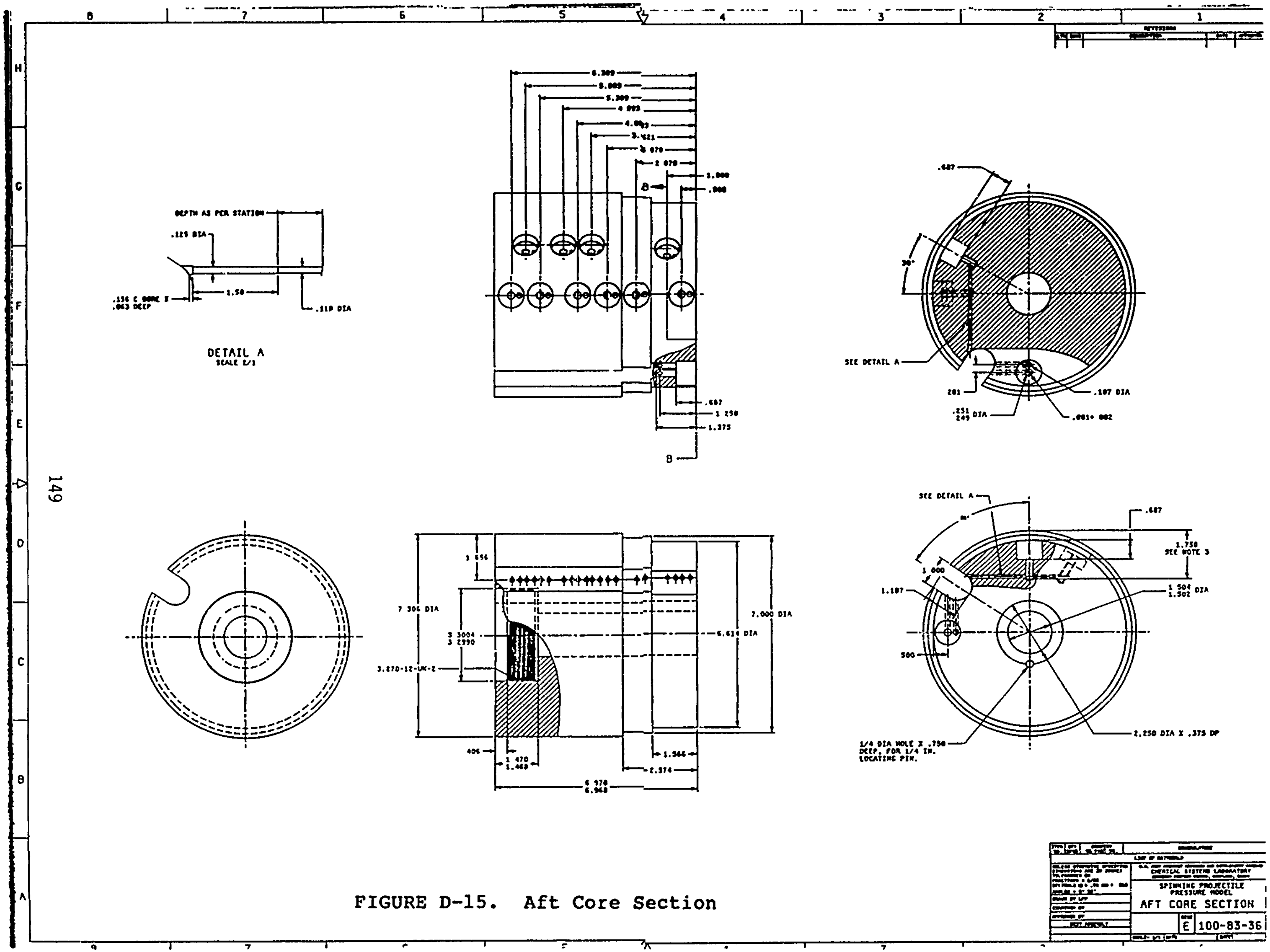


FIGURE D-15. Aft Core Section

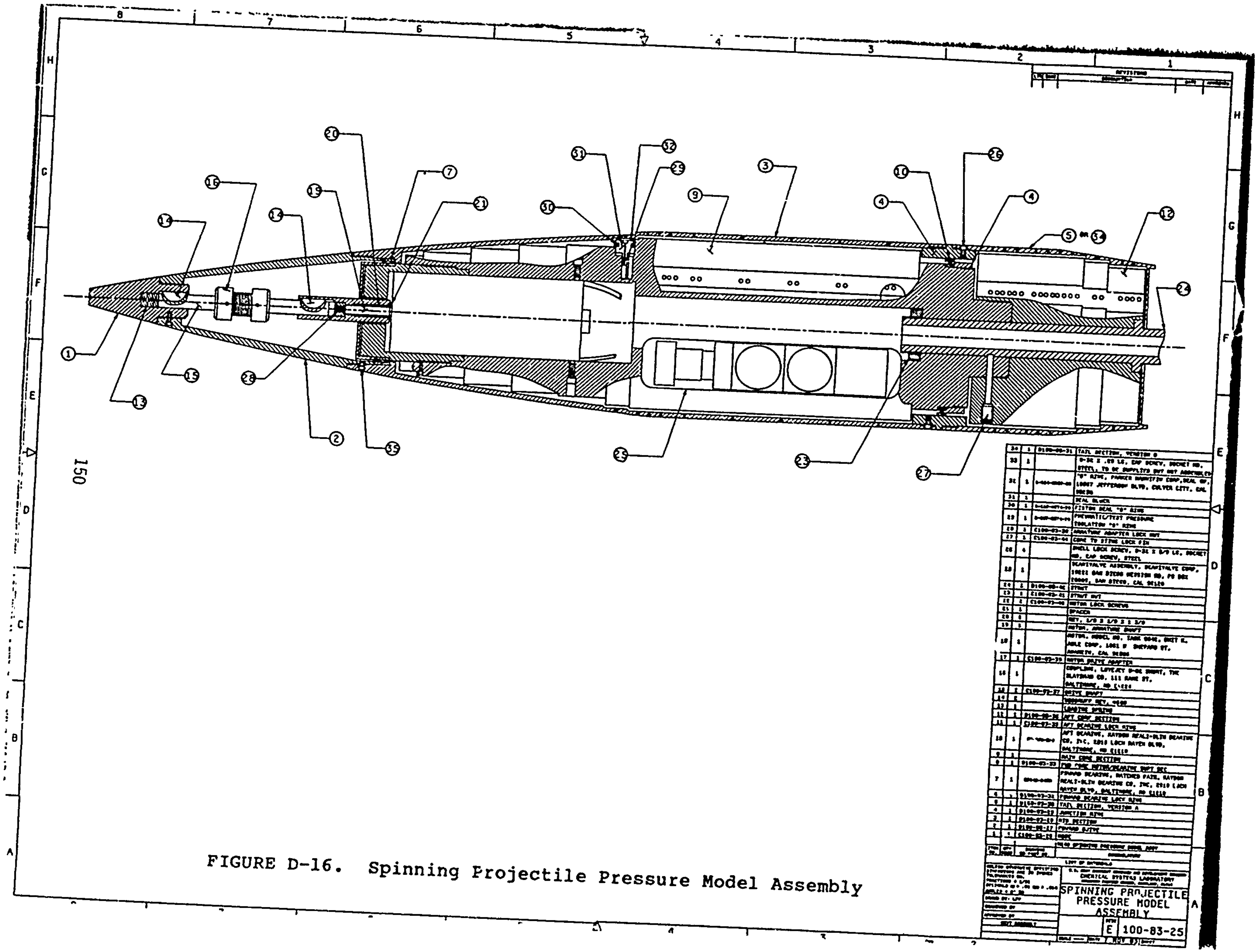


FIGURE D-16. Spinning Projectile Pressure Model Assembly

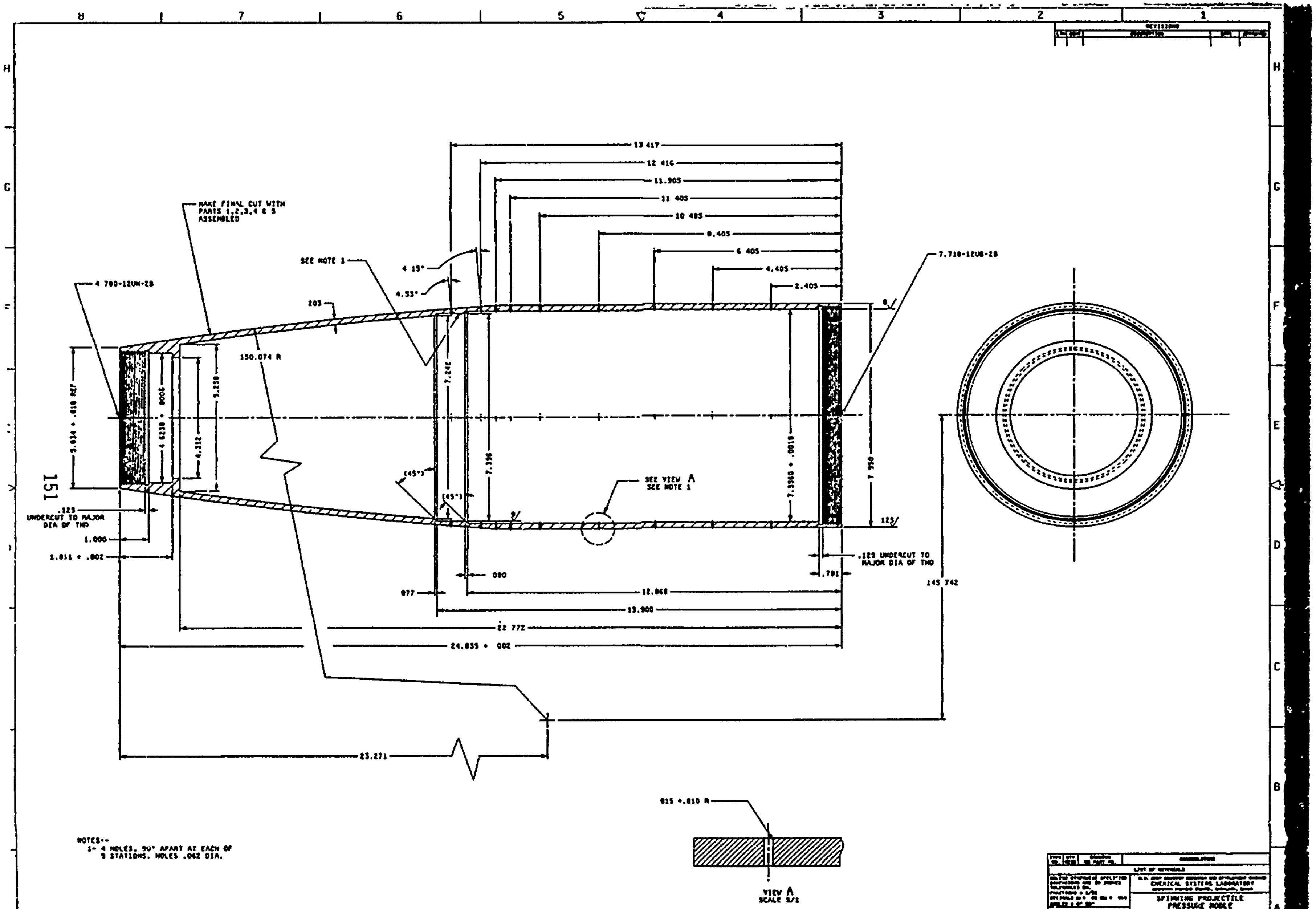


FIGURE D-17. Mid Section

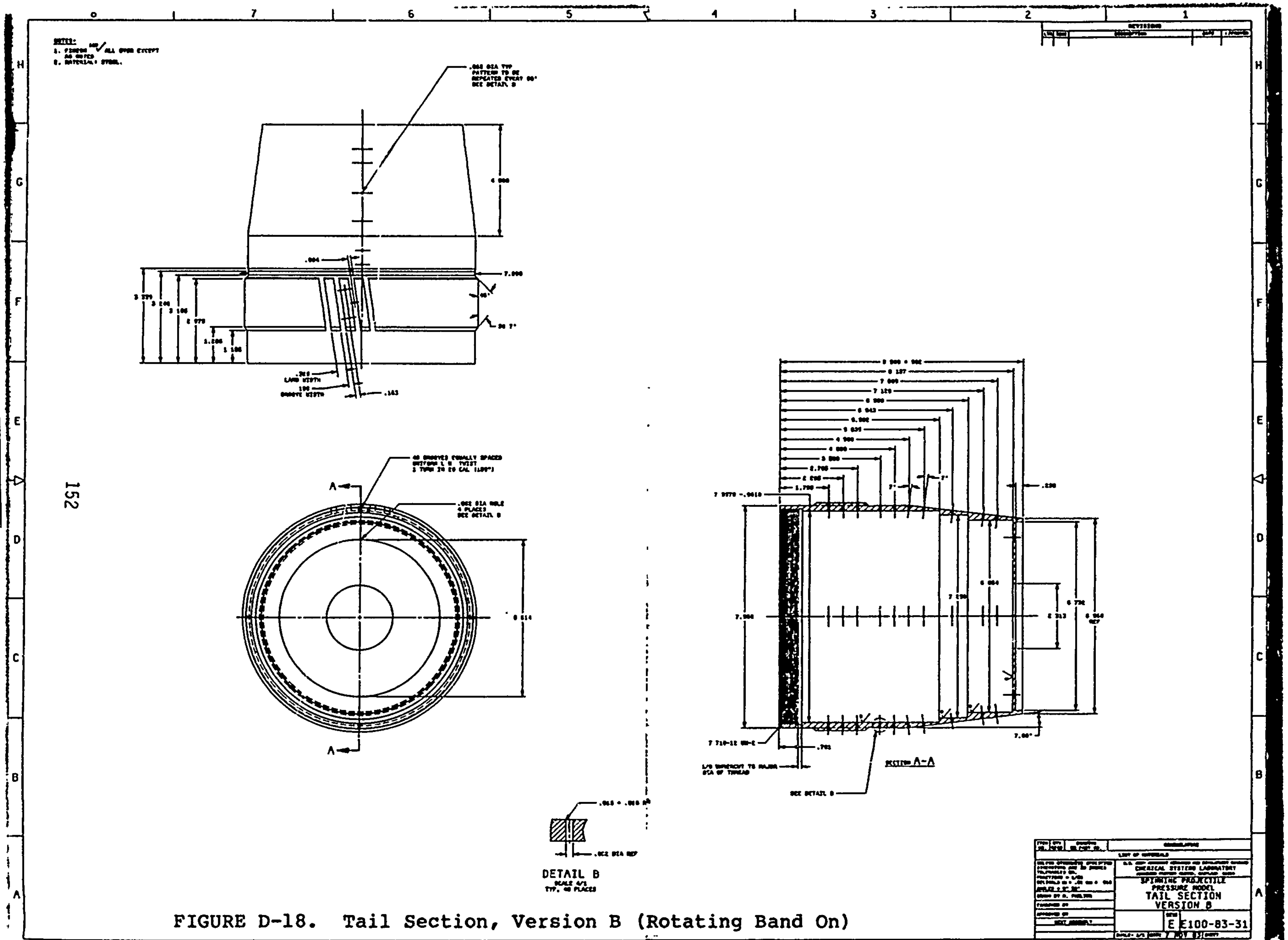


FIGURE D-18. Tail Section, Version B (Rotating Band On)

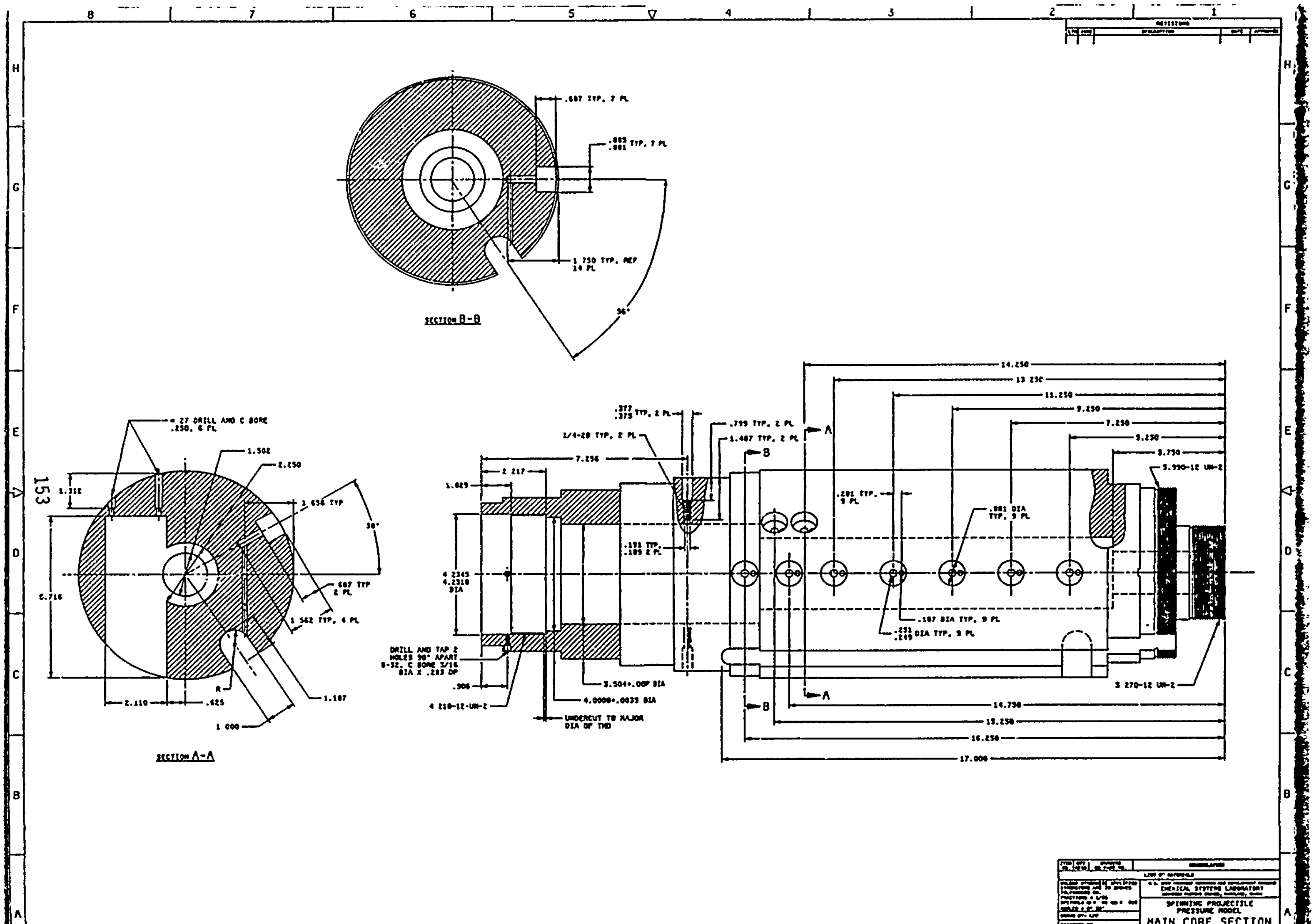


FIGURE D-19. Main Core Section (View 1)

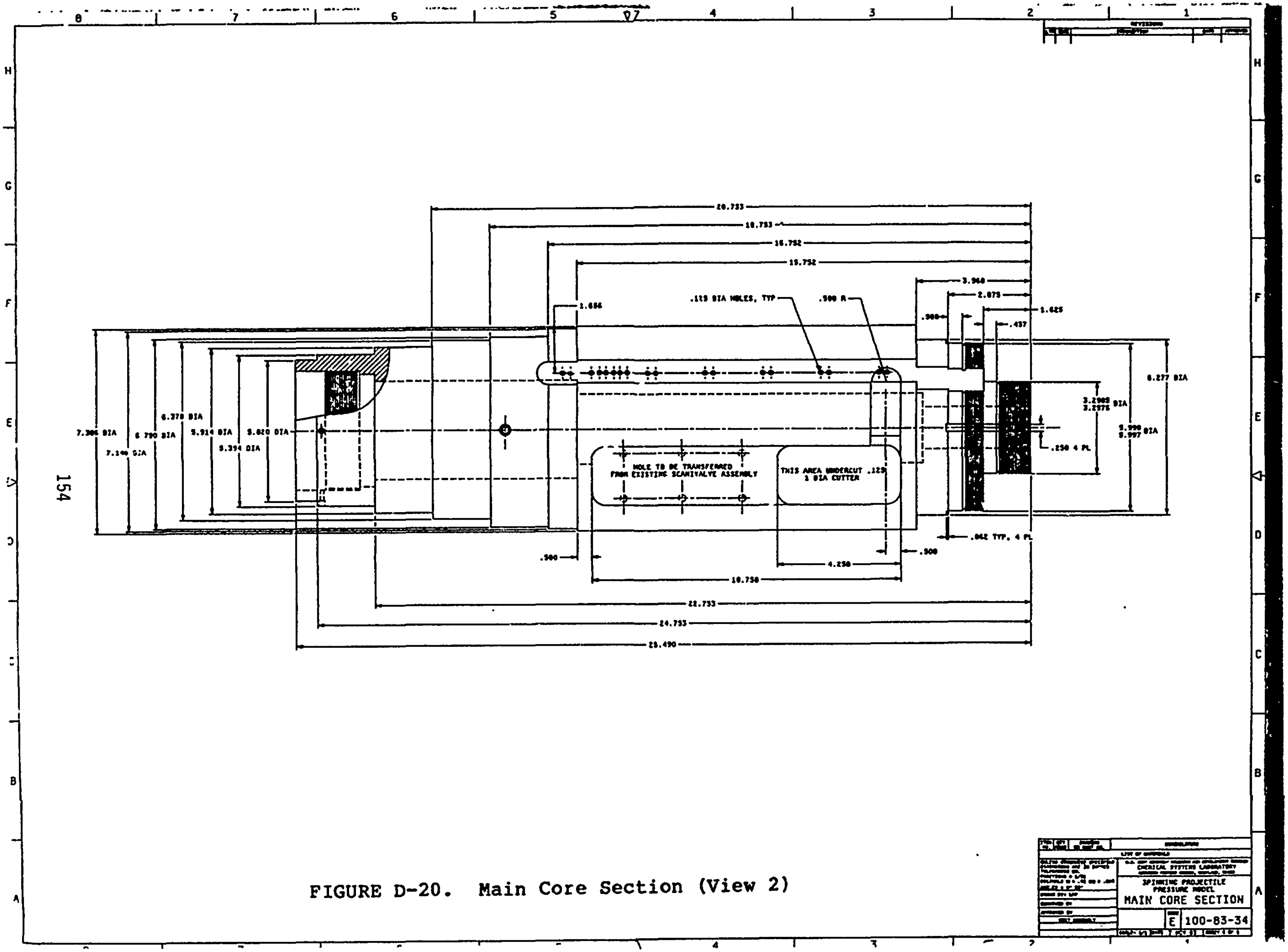


FIGURE D-20. Main Core Section (View 2)

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